The Welding Engineer

Reg. U. S. Pat. Office

Founded by L. B. Mackenzie, 1916

JULY, 1928 VOL. 13, NO. 7

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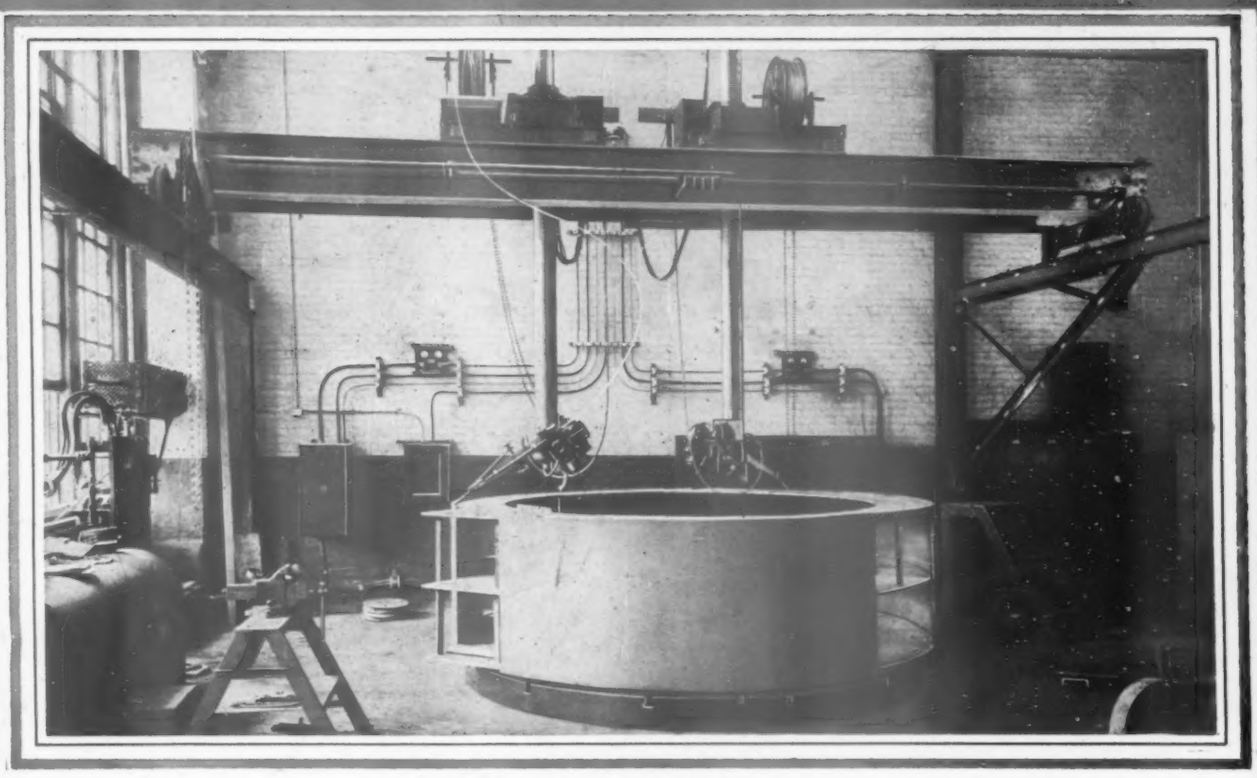

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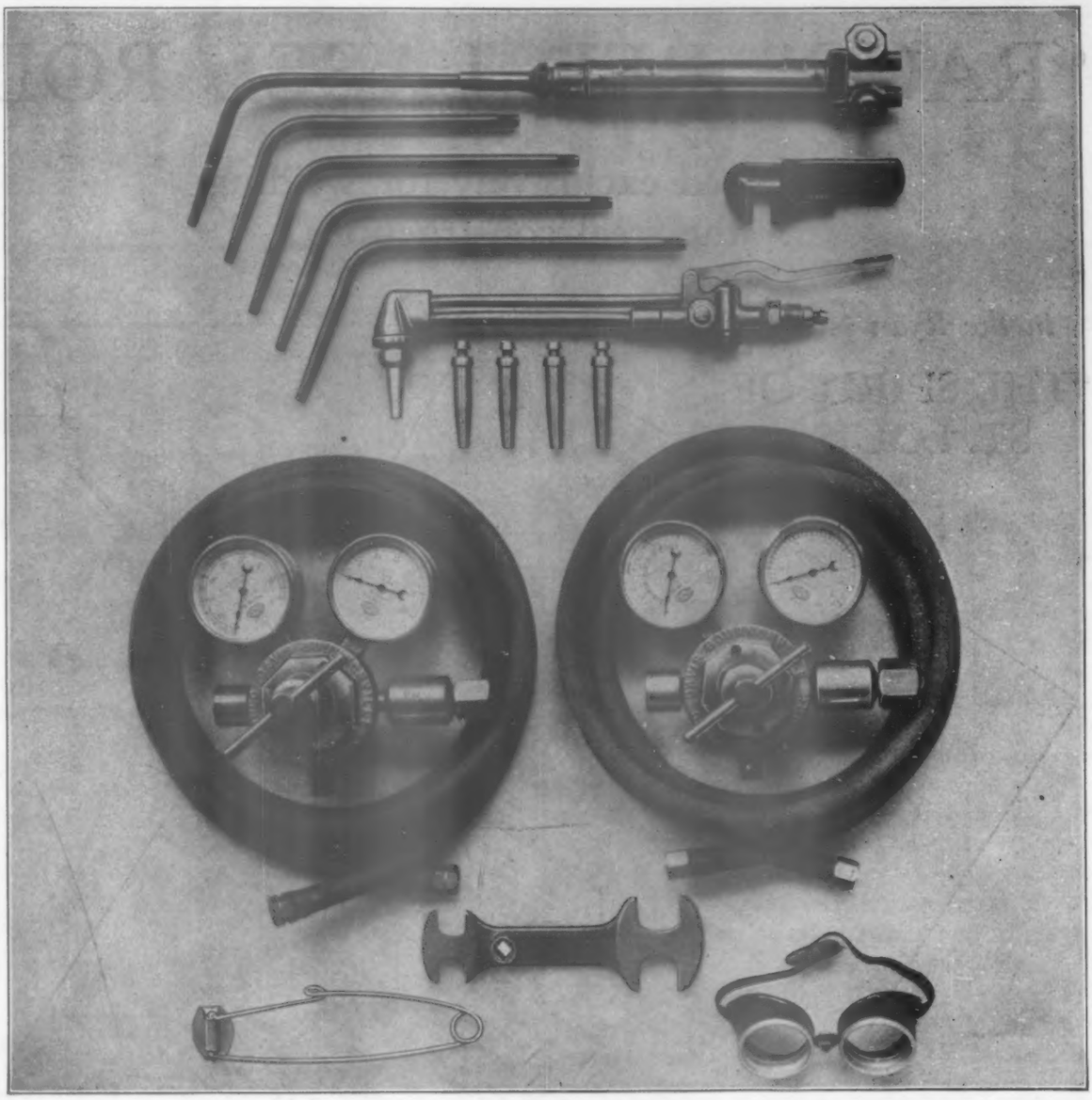

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America's Standard

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The Welding Engineer

Founded by L. B. Mackenzie, 1916

Volume 13 | July 1928 | Number 7

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Make Alibis Unnecessary

MAKING a new process pay dividends is not at all a matter of luck. The newer the process, the more care must be exercised to learn all the ins and outs of its application. Only the management can properly accept the responsibility for this, because in a new art all experience may not be good experience, and the workman is sure to need good technical direction for his efforts. In the case of welding, it takes a technically trained man or one of superior mechanical ability to grasp the full possibilities of the economies which it can accomplish. Such a man can vastly increase the financial returns from welding operations by studying the methods of other executives who have given to the process the attention which it deserves. Men who have made a success of welding, who are regarded as authorities on the subject, can save the new user from many a pitfall of fundamental error. By making use of their good counsel the welding supervisor has a better chance to report results rather than alibis. You will not find dissatisfaction with welding in plants where the management has taken the trouble to learn how to use it right.

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The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

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Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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At left: One of the arc-welded bull-nosed ends, used to terminate high-pressure headers; also, flange welded to the piping. Below: The 10-inch main steam header, showing welded collar joints.

STEAM PIPING *in the* St. Luke's Hospital of Cleveland

electrically-welded with WILSON WIRE

An offset made in the main steam header, showing the two arc-welded joints.

"Color-tipt"

Trade Mark Reg. U. S. Pat. Off.

IN building the St. Luke's Hospital, Cleveland, practically all the connections in the steam piping system were electric welded—and in all this electric welding work Wilson "Color-tipt" Wire was used *exclusively*. The work was done by The Smith & Oby Company, who put in the heating, plumbing and ventilating systems.

The right-hand photograph at the top of this page shows the method of joining lengths in the 10-inch main steam header, which runs across the front of the three high pressure boilers, and takes a pressure of 200 pounds per square inch. First, a small sealing weld was made at the scarfed ends, and then built up into a flush weld. Around the outside of this weld a steel collar was placed and welded to each pipe for mechanical strength. The joints in the curved pipes leading from the main steam header were made in the same fashion, and all flanges were welded to the pipes. The center illustration shows how the bull-nosed ends were built up to terminate the high pressure headers—an excellent example of the *strength* secured by *electric welding*.

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Now that welding has to make good—

The modern welder cannot be too particular in his choice of materials. People know more about welding than they did ten years ago. They know that good welds can be made, and that they can blame failures on poor materials rather than the process. Play safe with your reputation, by using

SWEDOX

WELDING RODS, WIRES and ELECTRODES

The selection of SWEDOX wires began when the welding industry began, and our engineers continued to study your requirements, and to select the materials which will give you the utmost satisfaction. Three warehouses are now stocked with welding materials which have been thoroughly tested so that their merits might be known accurately before they are delivered to our customers.

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We have recently become distributors of the products of

NATIONAL CARBON CO., INC.
Cleveland, Ohio

Our stock of National Welding Carbon Products is complete and includes Carbon Plates, Rods, Paste, Welding Electrodes and Graphite Electrodes.

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Lafayette 8500

DAYTON, OHIO
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Extended
East 150

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5001 Bellevue Ave.
Lincoln 6780

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A complete stock of all welding accessories, including goggles, helmets, shields, gloves, electrode holders, lenses, etc., is carried in each of our three warehouses. Include whatever accessories you need in your next order.

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TRADE MARK

Safety Regulator

IT is the outstanding development of the welding and cutting industry. ¶ Its greater safety, efficiency and reliability is based upon its design and the raw materials used in its construction. ¶ The regulator seat can be turned over or exchanged without special tools or detaching the regulator from cylinder valve. It can be done in 60 seconds.

Follow the path of the inrushing high pressure gas and you have the answer. From the cylinder connection the gases pass through two independent openings into large circular equalizing chamber of regulator body. Here gas meets gas. No impact friction. Spontaneous combustion of oxygen regulator seat eliminated. Then gases pass into smaller circular chamber *across* regulator seat and not against it. Seat and holder are self-aligning and in ball bearing housing.

VICTOR SAFETY REGULATORS will serve you well no matter where you are located. They are accurate, safe, sturdy and neither leak nor freeze. Their functioning does not depend upon repair stations. They are built for long service and safety.

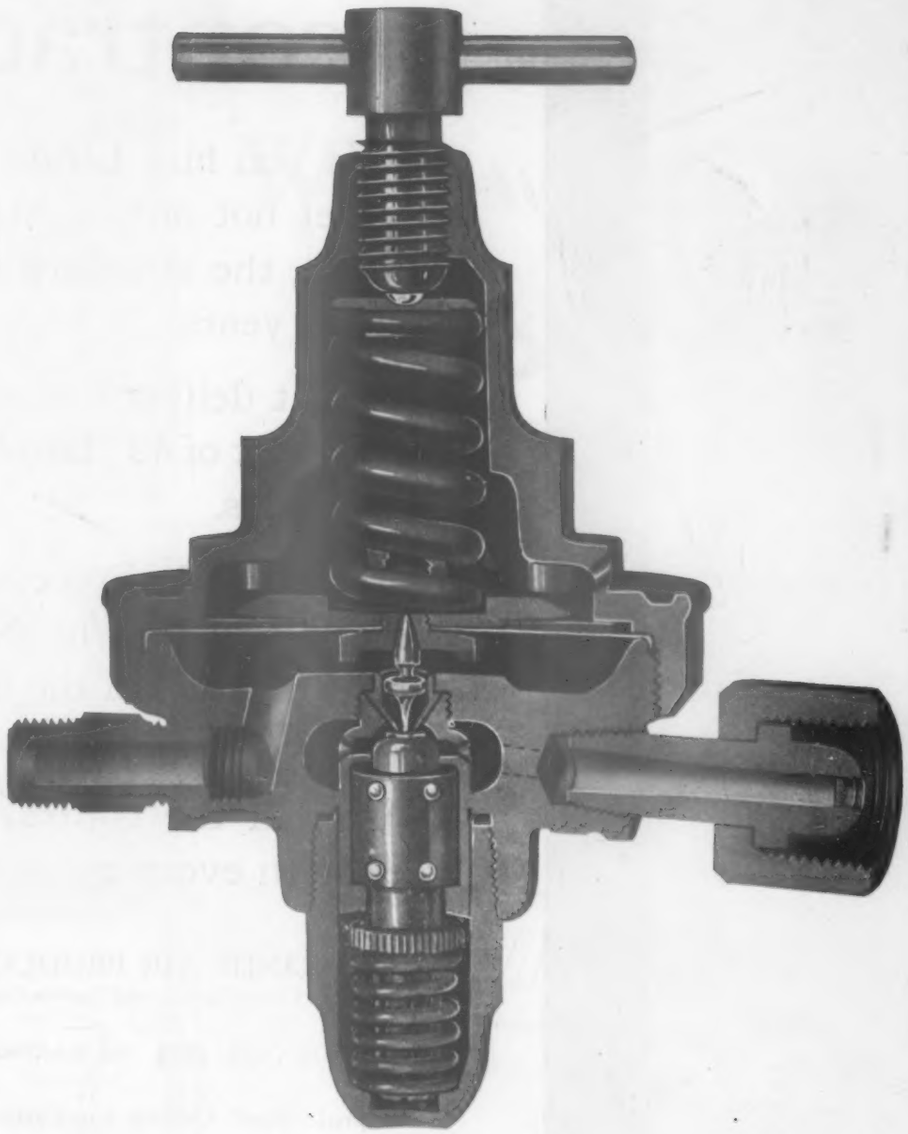
Direct us to forward to you detailed descriptive matter of the VICTOR SAFETY REGULATOR.

VICTOR OXY-ACETYLENE EQUIPMENT COMPANY

Executive Offices: 844 Folsom St., San Francisco, Calif.

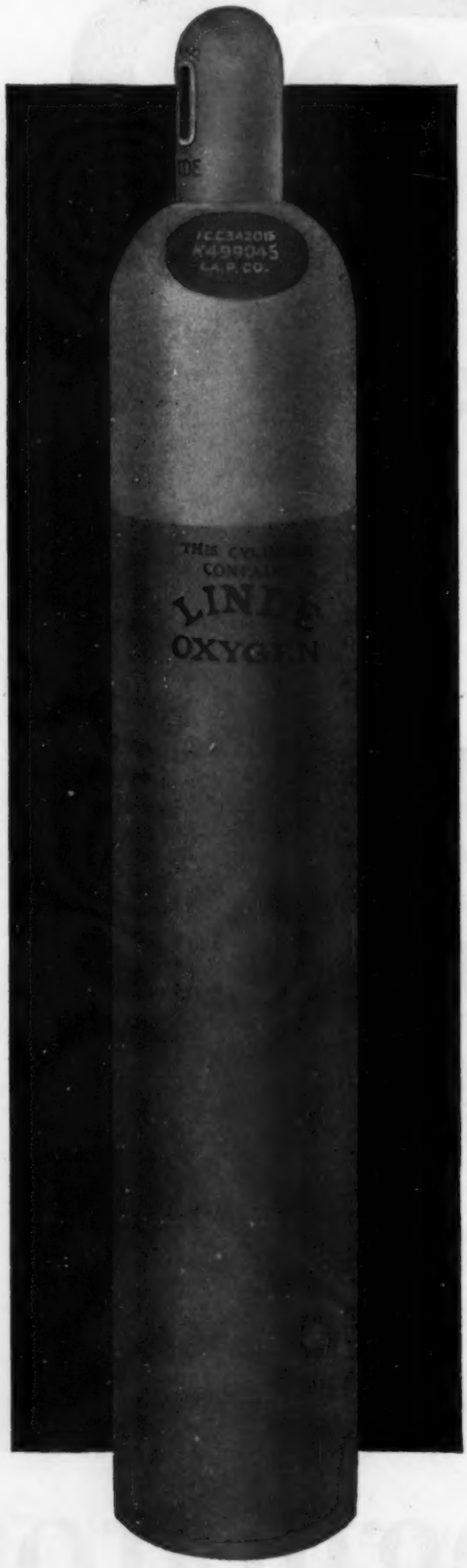
Manufacturers of Fine Welding and Cutting Equipment

VICTOR
TRADE MARK



PATENTS APPLIED FOR.

Safety Regulator



It isn't in the written contract

When you buy Linde Oxygen, you get not only a high grade product, the standard for more than 20 years.

And fast delivery service from the nearest of 49 plants and 103 warehouses.

But also Linde Process Service, always ready to help you get the best results in the most economical way.

It isn't in the contract, but it goes with every cylinder.

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Unit of Union Carbide and Carbon Corporation

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LINDE OXYGEN

Why we advertise

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DISSOLVED ACETYLENE

PREST-O-LITE is a standard product—tried and proved. It has been the leader of the industry for 23 years. Its uniform high quality and country-wide delivery service are facts well-known to every user. Prest-O-Lite is readily available from

31 *Producing Plants*— 103 *Warehouses*

But every day new users of the oxy-acetylene process are springing up. We want these newcomers to profit by the experience of the old-timers. And so we advertise that they may know that Prest-O-Lite is the dissolved acetylene of American industry.

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Unit of Union Carbide and Carbon Corporation
UCC
General Offices: Carbide and Carbon Building
30 East 42d St., New York
31 PLANTS—103 WAREHOUSES

If you had a Prest-O-Weld outfit you could make more money

JUST stop and figure out how much profit there is in welding jobs.

Then you will know why so many garages and repair shops are buying Prest-O-Weld outfits.

Prest-O-Weld blowpipes are made by the Oxweld Acetylene Company, makers of the famous Oxweld equipment.

You will be agreeably surprised at the price.

Sold by jobbers everywhere.

OXWELD ACETYLENE COMPANY
Unit of Union Carbide and Carbon Corporation

UCC

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NEW YORK CITY
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Adam Grant Bldg.

PREST-O-WELD

Why Save Pennies on Electrodes and Waste Dollars on Labor, Material and Quality Values?

MANY manufacturers have found that there is more to be considered than the actual *purchase* price of electrodes in applying the factor of welding material in production cost estimation.

The electrode which substantially reduces labor—both in actual welding and finishing—and current consumption, while producing a weld of the highest quality, is, in the final analysis, the most economical and efficient. QUASI-ARC Electrodes are scientifically designed on this principle, and our sixteen years of worldwide experience has proven it to be sound and practical.

Our experienced Engineers are prepared to prove the advantages of QUASI-ARC Electrodes by a practical demonstration in your own shop at no obligation to you.

Quasi-Arc

Pressure Main Bridge All-Welded in Situ

General View of Pressure Main

Hydraulic Pressure Main 5250' long, 575 lbs. per square inch test pressure. Pipe units welded in the shop 10' to 25' long; pipe units welded in situ 80' to 90' long. Quasi-Arc Electrodes were specified in consequence of sound engineering conclusions based on actual experience and tests.

QUASI-ARC INCORPORATED

Sole Manufacturers of Quasi-Arc Electrodes and Welding Equipments and Consultants in Reference to their Application

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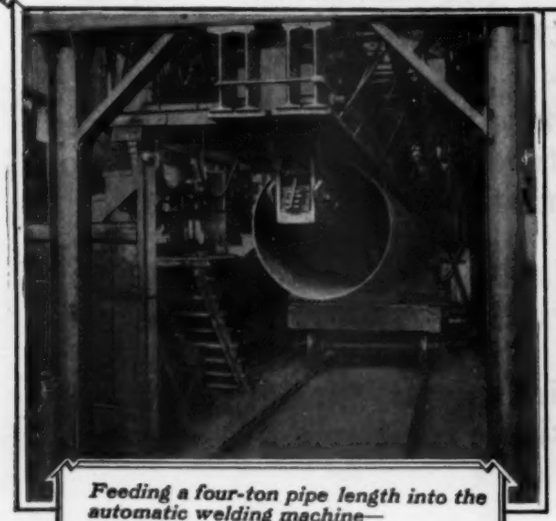
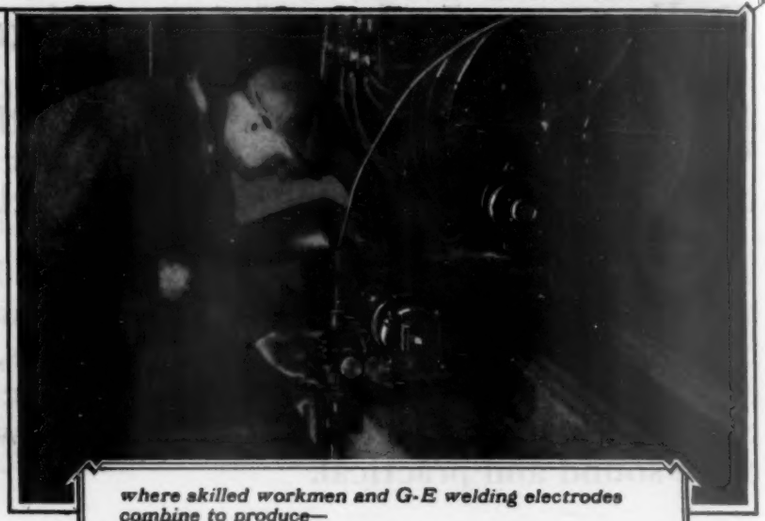
HARRISBURG CHICAGO CLEVELAND

G-E WELDING ELECTRODES



Feeding a four-ton pipe length into the automatic welding machine—



where skilled workmen and G-E welding electrodes combine to produce—

Welding the pipe that brings

Eight miles of special pipe were required for the new Springfield, Mass., water system. This pipe, ranging from 36 to 66 inches in diameter, was manufactured by the Walsh Holyoke Steam Boiler Works, Inc.

A steel plate, 30 feet long and one-half inch thick, properly trimmed, rolled, and the edges beveled, made one half-section. With the automatic, multiple-arc welding set and G-E welding electrodes, just 80 minutes were needed to transform two half-sections into a pipe length.

Rapid, automatic welding, to produce long-life welds, requires more than good machines and skilled operators—reliable welding electrodes are equally important. Two types of G-E welding electrodes were used to weld the eight miles of pipe—Type "B" and Type "F".

In absolute reliability of operation and over-all efficiency, G-E arc welders are unequalled. They are available in all sizes, all types—for either hand or automatic operation—for one or more operators.

GENERAL

MERCHANDISE DEPARTMENT

G-E WELDING ELECTRODES

a bead of uniform texture, strength, and lasting qualities.

In all, 45 tons of G-E welding electrodes were used to weld the pipe for this installation.

the water to Springfield

Only arc stability, rapid deposition, and good penetration by the electrode can produce tough, lasting welds. By actual test, every pipe length for the Springfield water system stood up under a water pressure far in excess of actual installation conditions.

Whether the welding involves a four-ton pipe length or a two-pound shell for an ice-cream can, you are safe when you use G-E welding electrodes. Three kinds are available:

Type "F" is used for the general welding of steel.
Type "B" is for automatic welding.
Type "A" is recommended for cast iron.

Special distributors for G-E welding electrodes, located throughout the country, are equipped to give you prompt service. Get in touch with the G-E Welding Electrode Distributor near you or write to the Merchandise Department, General Electric Company, Bridgeport, Conn.

THE MORE YOU ARC WELD THE MORE YOU SAVE

550-206

ELECTRIC

BRIDGEPORT, CONNECTICUT

Lad puts Pop right

"Here, Lad—

I've been around on a trip . . I came . . I saw . . I succumbed. You're right, lad, right as a trivet . . Arc Welding is here all right. I'm going to take up welding right away, and in a big way, too. I've just written to my buddie from whom I've bought motors for years, to come and tell me how they developed arc welding and to sell me the right kind of machines for our work. NOW, LAD, OUR SCRAPS ARE ALL OVER."

Only "Stable-Arc" Welders have all these features

Variable Voltage.
Laminated Magnetic Circuit.
Separately-excited Generator Field.
Double Control of Welding Heat.
Steady Arc Throughout Entire Welding Range.
All Steel Construction.
Full Capacity for either Metallic or Carbon Arc Welding.

These features make welding easier. Results—better welds and greater output.

Ask any Operator!

"No, Pop—

they've just started in earnest.

You've taken a step in the right direction with your right foot and have placed the left one on a banana peel . . and you know where that lands anyone.

What does his company know about arc welding development, except what they've picked up from Lincoln's trail blazing with the **FIRST** variable voltage welder in 1907 . . the **FIRST** application of welded steel to replacement of castings . . the FIRST application to buildings . . the **FIRST** application to bridges . . the FIRST to heavy steel pipe . . the FIRST to complete manufacture of motors?

And since you bring up motors, why doesn't your buddie's firm use welding on their motor if their welder has welding licked?

Lincoln has not only licked all welded motors with the Lincoln Welder but has also licked all motors with the welded steel motor.

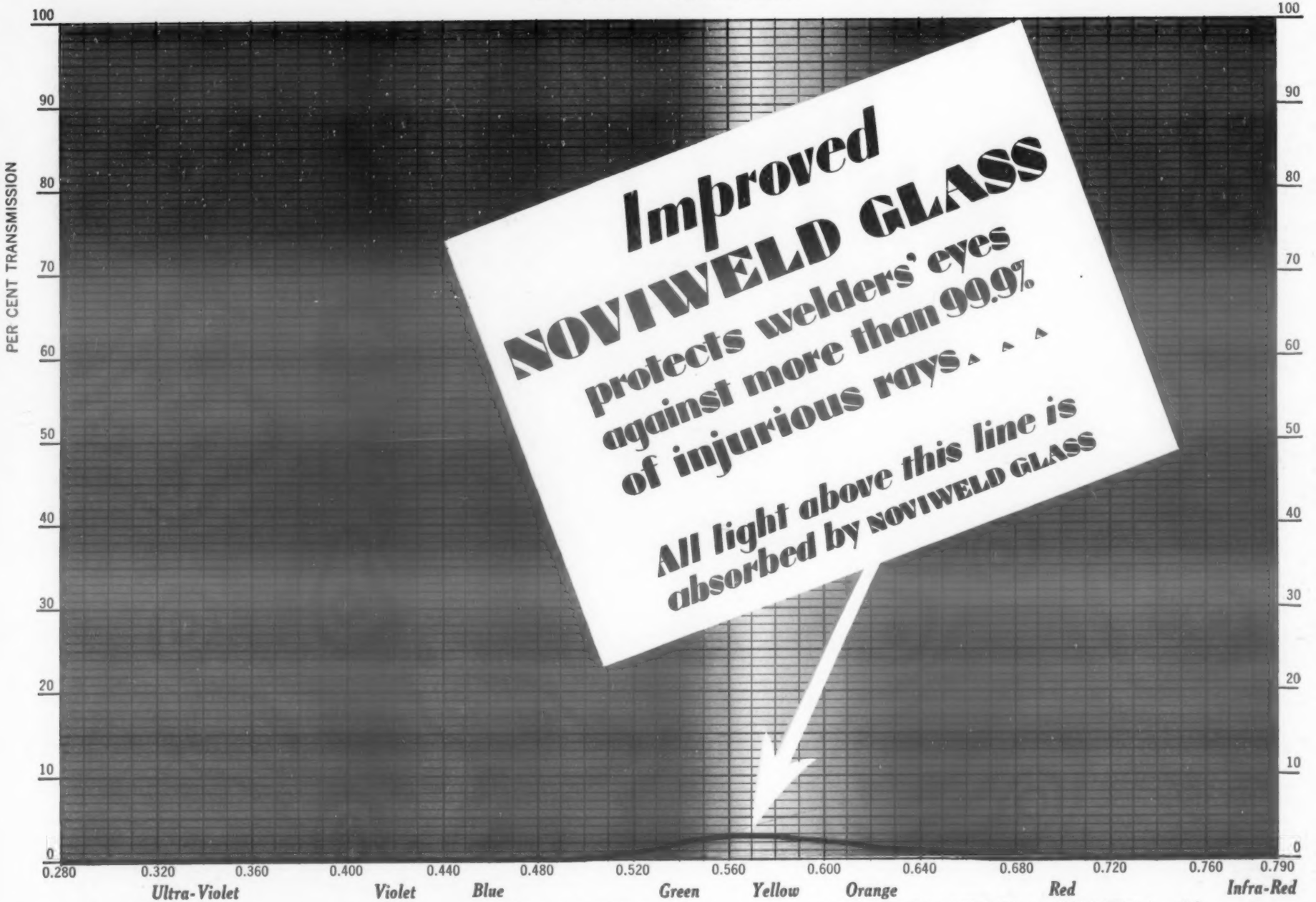
So why listen to your buddie? He will be like our minister who spoke the other day on the subject "A Living Wage." People WILL choose a subject with which they've had no experience."

The Lincoln Electric Co., Dept. No.27-7, Cleveland, Ohio

W-60

"Stable-Arc" LINCOLN WELDER

SPECTRAL TRANSMISSION



AMERICAN OPTICAL CO. DATE MAY 19, 1928 METHOD K-M S.PHOT Hilger U.V-T.C.L&N

SAMPLE NOVIWELD #6 SHADE FROM SHADE BAR #1 OBSERVER S.J.W.

REMARKS: THIS #6 SHADE IS ONE OF THE LIGHTEST GLASSES USED FOR WELDING

See next page for further WELDING glass facts

Improved NOVIWELD GLASS

FOR WELDERS' HELMETS AND GOGGLES

Greater Eye Protection

HAND in hand with the use of larger welding rods comes the need for more efficient Protection Glass for the welder. New Noviweld (NW) gives practically complete protection against infra-red and ultra-violet, and at the same time retains a desirable soft green color giving greater detail of work without fatigue.

No other welding glass gives the sure protection or the comfort of the new Noviweld (NW). It is a complete safeguard against the sensation of "hot sand in the eyes," red eyelids and other annoyances common to the job.

We suggest . . . New Noviweld

No. 5 shade for acetylene burning.
Nos. 6 and 8 shades for acetylene welding.
Nos. 10 and 12 shades for iron and carbon welding.
Nos. 14 and 16 shades for atomic arc welding.

(NW)
Look for this trade mark on every genuine Noviweld Lens

Hardy Welding Goggle
For burning and welding

Prices of Noviweld Lenses and Plates

	List	Lots 100
Hardy Welding Goggle with Noviweld Lenses	*$2.50*	*$2.15*
Lenses 47 mm or less	*1.50*	*1.25 per pr.*
Lenses 50 mm	*2.00*	*1.50 per pr.*
Plates for Welding Helmets		
Plates 2 x 4¼	*2.75*	*2.00 each*
Plates Sq. Inch	*.35*	*.25*

AMERICAN OPTICAL COMPANY

NEW YORK — ST. LOUIS — SAN FRANCISCO — CHICAGO — KANSAS CITY—ATLANTA

Goggles for Every Industrial Need

WHAT IS INSIDE
AN ACETYLENE CYLINDER?

Every acetylene cylinder must contain a porous filler which is put there for only one reason, namely *safety.*

After an acetylene cylinder has been in service *there is no way of inspecting the filler without destroying the cylinder.* Therefore the permanency and durability of the filler is of vital concern to both acetylene producers and acetylene users.

MOST acetylene producers and many acetylene users advocate monolithic filled cylinders, because they know that this type filler will always perform its sole function, which is safety.

THE monolithic filler is composed of porous ingredients *held together with cement* so that it forms a solid, permanent, porous, stone-like mass inside the steel cylinder shell.

MORE than 25 years' experience in actual service has proved conclusively that *this filler can not deteriorate or sag,* consequently no need for any inspections. 100% safety is assured at all times and under all conditions.

ACETYLENE producers using monolithic filled cylinders have paid a premium in order to supply their customers with the best and safest type of acetylene cylinders that the industry has developed. Such concerns deserve your acetylene business.

Booklet Upon Request

KEITH DUNHAM COMPANY

110 South Dearborn Street Chicago, Illinois

Ten Advantages Which

The Owen Induction Welder

Gives Your Welding Operations

1—Low initial cost.

2—Minimum operating expense.

3—Thorough penetration.

4—Short, smooth arc, producing highest quality welds.

5—Cast and malleable iron easily welded, and readily filed, machined, drilled.

6—Simple to operate. Arc easily struck and maintained.

7—Cannot overheat. No cooling device.

8—Complete in itself. No auxiliary equipment.

9—No moving parts. Nothing to wear out.

10—Very light and easily portable.

Furnished with complete equipment, ready to install and operate

Approved and Accepted by the National Board of Fire Underwriters' Association

You can't buy the Owen Induction Principle at any price in any other than the Owen Welder. It is this scientific principle that provides the above vital advantages, and it is these advantages that pull more business into your shop because you can do a better job at a lower cost. The Owen Induction Welder is a big asset to any welding shop.

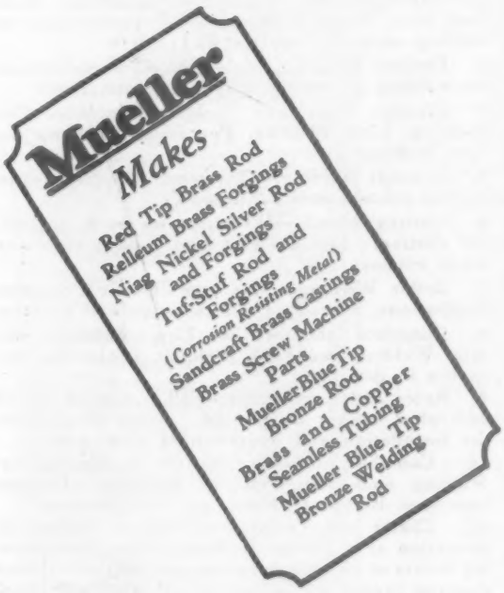
OWEN ELECTRIC WELDER CO.

General Distributors

717-718 W. O. W. Building **Omaha, Nebraska**

"Three Generations of Brass Making" Do Make a Difference in the Finished Product

Mueller
WELDING
BRONZE ROD



IF you have never used Mueller Welding Bronze Rod you are overlooking a product that will enable you to do better work and to do it in less time.

Quality isn't left to chance in Mueller manufacture. Careful analysis of each heat as it is poured insures a uniform product.

Mueller Welding Bronze Rod makes sound, strong, non-porous welds. It flows evenly and freely. Absence of porosity eliminates sputtering and explosions.

Find out for yourself the quality of Mueller Welding Bronze Rod. We'll gladly mail you a generous sample free. Drop us a line with your address, we'll do the rest.

Mueller Brass Co.
PORT HURON MICHIGAN
DETROIT DISTRICT

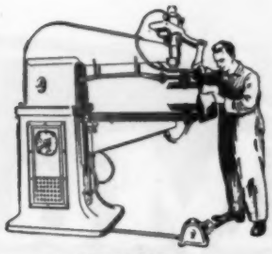
Mueller Brass

THREE GENERATIONS OF BRASS MAKING

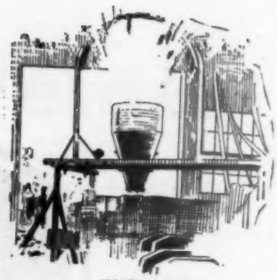
No matter what kind of welding you do--

OXY-ACETYLENE

ELECTRIC ARC



RESISTANCE



THERMIT

YOU NEED

The Welding Encyclopedia

New Sixth Edition

It describes in detail the theory and practice of every welding process.

It tells how to weld every weldable metal by each of the welding processes.

It gives detailed instructions for handling the important welding jobs, such as boiler welding, sheet metal welding, tank welding, pipe welding, etc.

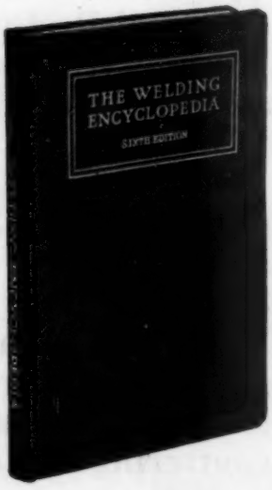
It tells how to prepare parts for welding.

It tells how to install and care for welding equipment.

It explains the meaning of all words and terms found in welding literature.

It tells where to buy standard makes of welding apparatus and supplies.

The Sixth Edition contains much new and valuable data on Bronze Welding, Structural Welding, Welding of Stainless Steels, Resistance and Thermit Welding, Rail Bonding, and Design Data for Production Welding.



496 Pages
645 Illustrations
Flexible Leather Grain Binding
Price $5.00

Contents

1. Illustrated encyclopedia covering all words, terms, and trade names used in welding.
2. Oxy-Acetylene Welding.—Aluminum, Steel, Cast Iron, Brass, Bronze. (Full instructions for welding each of these metals.)
3. Electric Arc Welding.—Complete instructions for welding all metals, studding, cutting, etc.
4. Electric Resistance Welding.—Includes Butt Welding, Line Welding, Percussion Welding and Spot Welding.
5. Thermit Welding.—The most complete treatise on this process ever published.
6. Cutting Metals.—Treatises on both gas and arc cutting. Includes cast iron cutting and automatic cutting.
7. Boiler Welding.—Gas and Electric Processes. Suggestions, procedure, and standards of practice.
8. Complete chapters on Pipe Welding, Rail Joint Welding and Tank Welding, explaining procedure in detail.
9. Rules and Regulations.—What can be welded and what cannot be welded. Rules also govern the installation and operation of equipment.
10. Complete instruction courses in Electric Arc Welding and Oxy-Acetylene Welding. Lessons, Exercises, Reference Readings, Examinations.
11. Charts and Tables.—A fund of welding information at a glance. Includes color chart showing colors at various temperatures, and color chart showing proper adjustment of oxy-acetylene welding flame.
12. Condensed Catalogs.—Up-to-date information about the leading makes of welding apparatus and supplies. The Buyers' Index is a convenient and reliable guide to the man who purchases or recommends welding apparatus.

THE WELDING ENGINEER PUBLISHING CO.,
608 S. DEARBORN ST., CHICAGO, ILL.

Please send me a copy of The Welding Encyclopedia, Sixth Edition, for which find enclosed five dollars. I understand that I may keep it for five days for examination and if it is not satisfactory I may return it and you will refund the purchase price.

Name .....

Street .....

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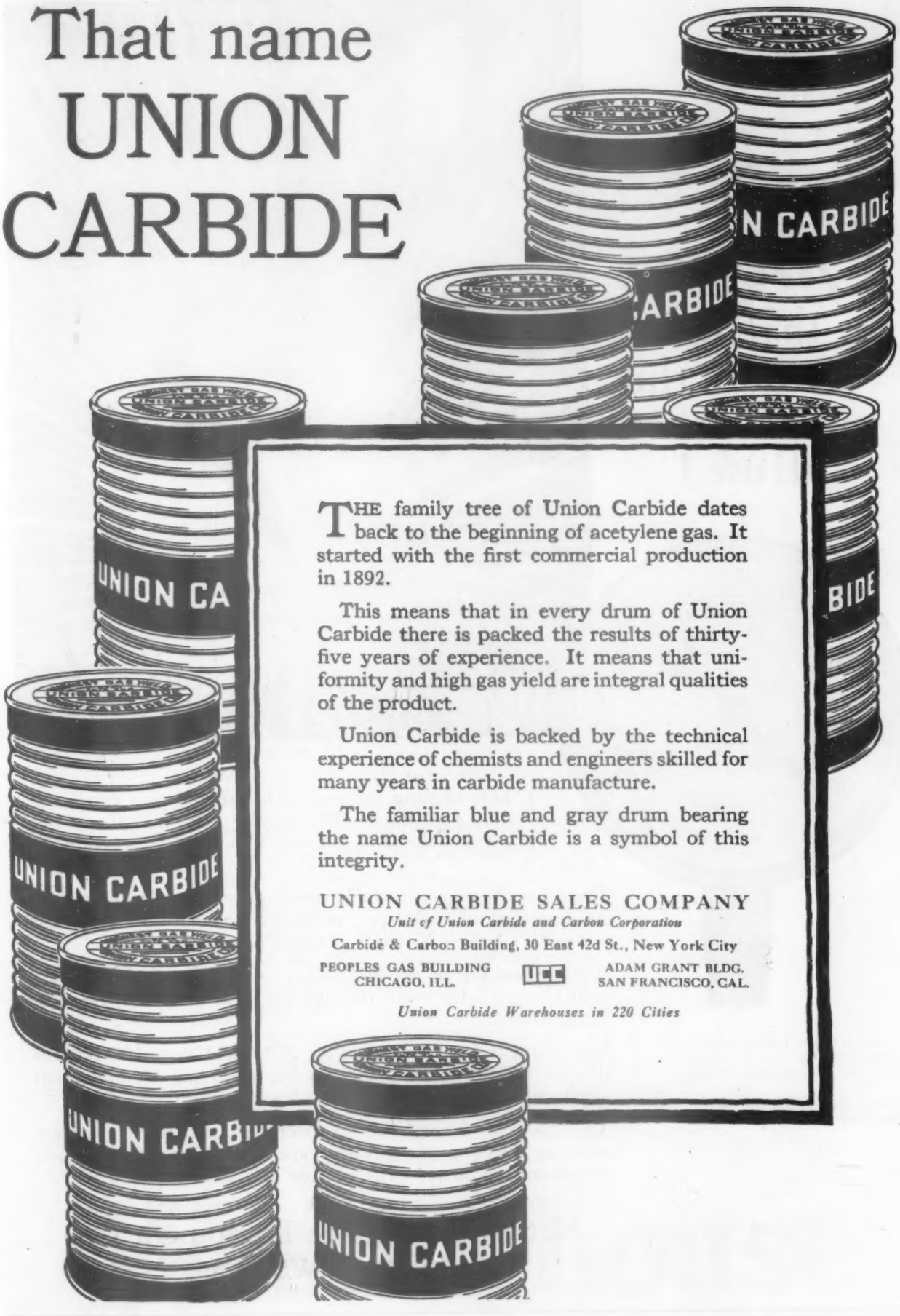
That name UNION CARBIDE



THE family tree of Union Carbide dates back to the beginning of acetylene gas. It started with the first commercial production in 1892.

This means that in every drum of Union Carbide there is packed the results of thirty-five years of experience. It means that uniformity and high gas yield are integral qualities of the product.

Union Carbide is backed by the technical experience of chemists and engineers skilled for many years in carbide manufacture.

The familiar blue and gray drum bearing the name Union Carbide is a symbol of this integrity.

UNION CARBIDE SALES COMPANY

Unit of Union Carbide and Carbon Corporation

Carbide & Carbon Building, 30 East 42d St., New York City

PEOPLES GAS BUILDING
CHICAGO, ILL.

UCC

ADAM GRANT BLDG.
SAN FRANCISCO, CAL.

Union Carbide Warehouses in 220 Cities

The Gauge.. that has stood the acid test of *use*

THE welding gauges you use should pass two tests. One you think of naturally; do they bear the approval of the Underwriters Laboratories? (Natweld Gauges do).

The other, however, is much more important. Do they bear the approval of the users, under every condition of actual service? (Again, Natweld Gauges do).

It is the acid test of use that makes or breaks a product. Natweld Gauges have come through every acid test of use with flying colors.

As a result the great demand for Natweld Gauges from users all over the world has made possible a volume of production that brings the price remarkably low.

An experienced corps of engineers is maintained to assist users in selecting the proper type of instrument for their equipment. You are urged to use this service.

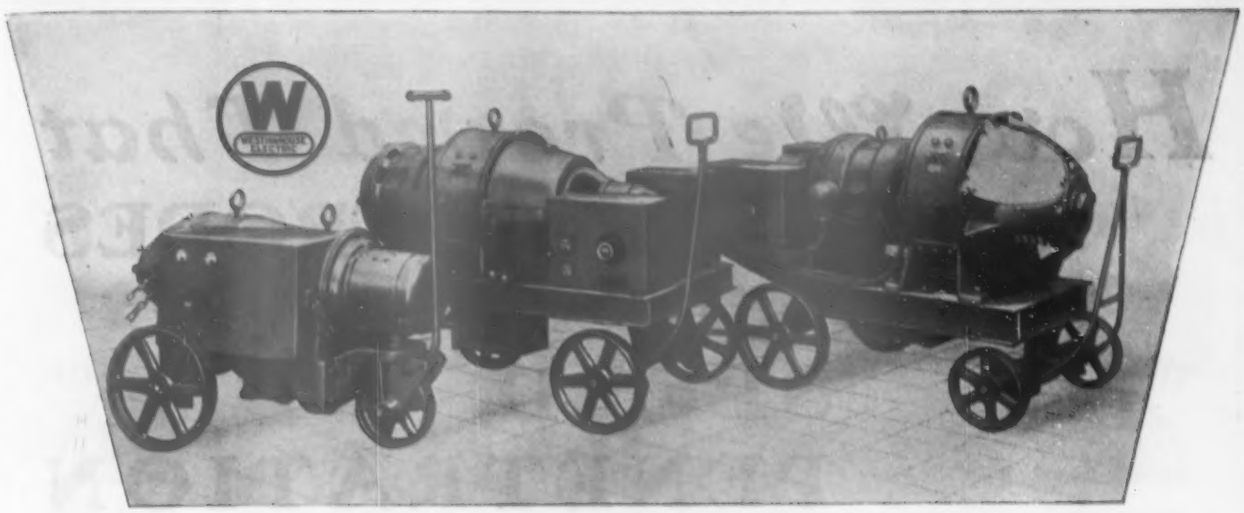
Represented in Illinois, Indiana, Wisconsin, Minnesota, Missouri by Joseph Halla, 333 No. Michigan Ave., Chicago

Canadian Offices, Hamilton, Ont. (MotoMeter Co. of Canada Ltd.)

National Gauge & Equipment Co.

La Crosse, Wisconsin

Division of the MotoMeter Co., Long Island City, N. Y.



THREE OF A KIND

Each a Trump Welding Set

Many manufacturers have turned to arc welding as a means of improving their products and increasing production—accomplishing both with much saving in cost. Also, the arc is being used in the erection of structural steel work. ¶Westinghouse, anticipating the advance of welding applications, developed three entirely new welding machines. They are built to meet the requirements of modern welding—requirements which have increased with the expanding use of arc welding. The three welding sets have ratings of 200, 300 and 400 amperes with welding ranges of 60 to 300, 75 to 400 and 100 to 500 amperes respectively. ¶The design of these machines, like their operating characteristics, is strikingly new. The generators respond instantly to variations in voltage caused by changes of arc length. It is easy to strike and maintain an arc—one arc strike per length of electrode rod being common practice with these sets. ¶Write our nearest district office for Leaflets 20340-A and 20346 which give the performance and qualifications.

Westinghouse Electric & Manufacturing Company
East Pittsburgh Pennsylvania

Sales Offices in All Principal Cities of
the United States and Foreign Countries

Westinghouse

X97165

How We Proved That KORO ELECTRODES *Excel In* SPEED PENETRATION AND QUALITY

TRY "KORO" (Patent applied for) ELECTRODES

Several months ago we produced, as a result of a long series of experiments, an entirely new type of arc welding electrodes suitable for either hand welding or automatic welding. Our laboratory tests indicated that they were far ahead of anything else on the market for speed, penetration, and soundness of weld metal.

Before announcing these new electrodes, which are intended primarily for production welding, we decided to make them prove their own qualities. Samples were tried out on a test basis in a selected list of production welding shops which are nationally known for volume and the quality of their welding operations. We felt that this was the most severe and convincing test we could use on these electrodes before announcing them to the public.

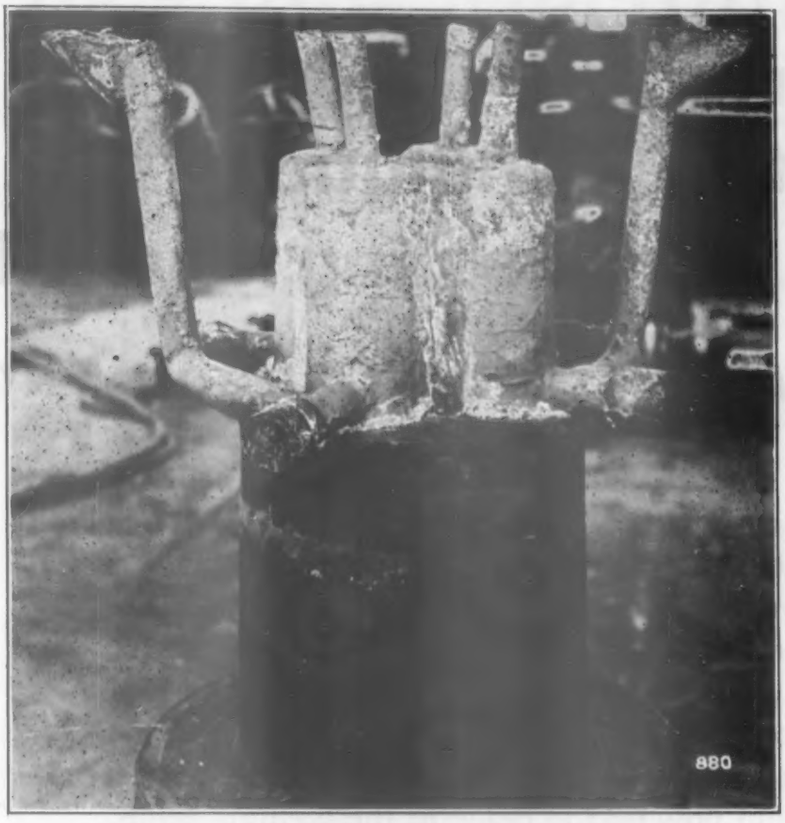
In every case the first tests resulted in a substantial order for these new KORO electrodes. Still we were not satisfied—then the first re-orders began to come in. We waited several weeks more and noticed that the re-orders continued. Today these re-orders are increasing in volume to such a degree that we have been obliged to greatly increase our production facilities.

The unanimous approval which the new KORO electrodes have received in plants where the requirements are very exacting, and the continued volume of repeat orders, is convincing evidence that we are in a position to offer welding shops a product which is distinctly valuable on account of the economies which it makes possible.

Back of this product is a skillful engineering staff, intimately acquainted with all phases of production welding and able to cooperate with your welders in perfecting your welding procedure. A trial order will convince you that you need KORO electrodes to bring your welding thoroughly up-to-date.

KORO CORPORATION
WAUKEGAN, ILLINOIS

Railway
Steel Mill
Industrial
Marine



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EDITORIAL

Make the Philadelphia Meeting Sell Welding

LAST YEAR the showing made by the welding industry at Detroit was impressive. Conditions were ideal for bringing the welded joint to the attention of men who are in the best position to use it and perfect it. Some of the developments in the industry since that event have been spectacular in the refutation of what had been considered as handicaps; for example, the operation of a railroad across an all-welded bridge. Our industry has more to sell than ever before, and the leaders have arranged a show place in the heart of a great metal manufacturing and fabricating district, a location which can easily draw local attendance from eighteen million people. Concurrent events, however, are bringing to Philadelphia hundreds of industrial engineers from every section of America, and they are all coming to learn. A good display of welding apparatus and welding materials is assured, but the promised attendance warrants a strong effort for more than a mere display of merchandise. All exhibitors should endeavor to show what welding can do in advance of what it is doing and how welding can be further improved in plants where it is accepted as standard practice. Make the Philadelphia event an educational one in every sense of the word.

Portability of Arc Welding Increases

ONE of the greatest handicaps to arc welding in the early days of its development was the lack of portability of equipment. A great many possible uses remained undeveloped because of the big difficulties in the way of taking equipment to the work. The first step in securing portability was providing a generator which could be driven by a gasoline engine. This was closely followed by the manufacture of several different types of generators with a gas engine attached. Such an equipment was almost indispensable to commercial welders who had to do a great deal of outside work and the larger welding shops all over the country have fleets of from 2 to 15 trucks on which are mounted assemblies of this type. In a great many cases these portable equipments are a great deal in the nature of a home-made affair, heavier and more expensive to operate than they need to be, with the added disadvantage in a great many cases that broken parts would have to be made up for replacement. Truck and tractor manufacturers have been rather slow to see the possible market for a complete welding unit capable of moving under its own power and so constructed as to offer the maximum advantage of compactness, lightness and economy of operation and ease of replacement of parts. Such units have, however, been introduced to the market recently and the fact that they are available greatly increases the range of welding operations. Welding can now be planned for any locality which can be reached by a truck or tractor and the equipment for doing the work is dependable on short notice. Undoubtedly the rapid development of structural welding which involves a large amount of field work and the increased confidence in the use of welding for repair work in such places as refineries, ship yards, etc., have encouraged the development of the complete portable unit. All those who are interested in the extension of welding operations should be posted on these new developments in equipment because they have added a lot to the highly desirable factor of portability.

Sell More Generators

AN ENGINEER who has recently completed a long series of investigations of welding operations remarks upon the surprising number of places where great economies could be accomplished by using acetylene generators but officials seem to take the use of dissolved acetylene as a matter of course. A brief survey of current sales and advertising efforts of generator manufacturers shows clearly enough that no very strenuous effort is being made to sell generators and it is unfortunate that this should be the case. It is true that the use of dissolved acetylene has many advantages and that in lots of cases these advantages are important enough to offset the difference in the gas cost. It is doubtful, however, if sufficient study has been given to the problem of determining under what conditions the use of a generator is more desirable. One generator manufacturer reports that a customer in a foreign country claimed that his generators were saving their cost every 90 days. All generator manufacturers should know how to determine when savings like this can be accomplished and more activity of this sort would be beneficial to the gas manufacturers and gas apparatus manufacturers, since it would make it possible to take every opportunity to keep the cost of gas welding at a minimum, without impairing the quality of the work which can be done by the process. It is known that this country produces the finest operation and safest generators made anywhere in the world; in fact all of the standard makes are practically accident proof when operated with any degree of common sense. A piece of equipment which has so much to offer the industrial world deserves to be more vigorously sold.

Peanut Shells

THE use of gypsum fiber concrete and structural gypsum has created a demand for wood chips which are mixed with calcined gypsum and water to form the concrete. A recent report of the Bureau of Standards points out that these chips have formerly been hard wood planer shavings of specified dimensions and indicates that the quantity formerly demanded was sufficient to make the price of wood chips an appreciable item in the cost of construction. Now the Bureau has been considering the use of peanut shells which can be secured at a price slightly higher than the transportation cost, consequently promising to become an economical substitute for wood. Reports from early experiments seem to indicate that it is just a matter of research to develop methods of treatment which will make the substitution satisfactory. It would not occur to the layman to imagine that in a country so rich in natural resources engineers would be using time and money to find a commercial use for peanut shells. It is, however, a striking example of the high value which is placed on research work in some industries. Research of this same character has really done a lot for the advancement of the welding industry, but there are a number of men in important positions in the industry who are not aware of this and consequently they discount the value of research. To them the use of peanut shells as a building material might seem absurd. The fact is that the welding industry needs research of this sort to keep it moving progressively.

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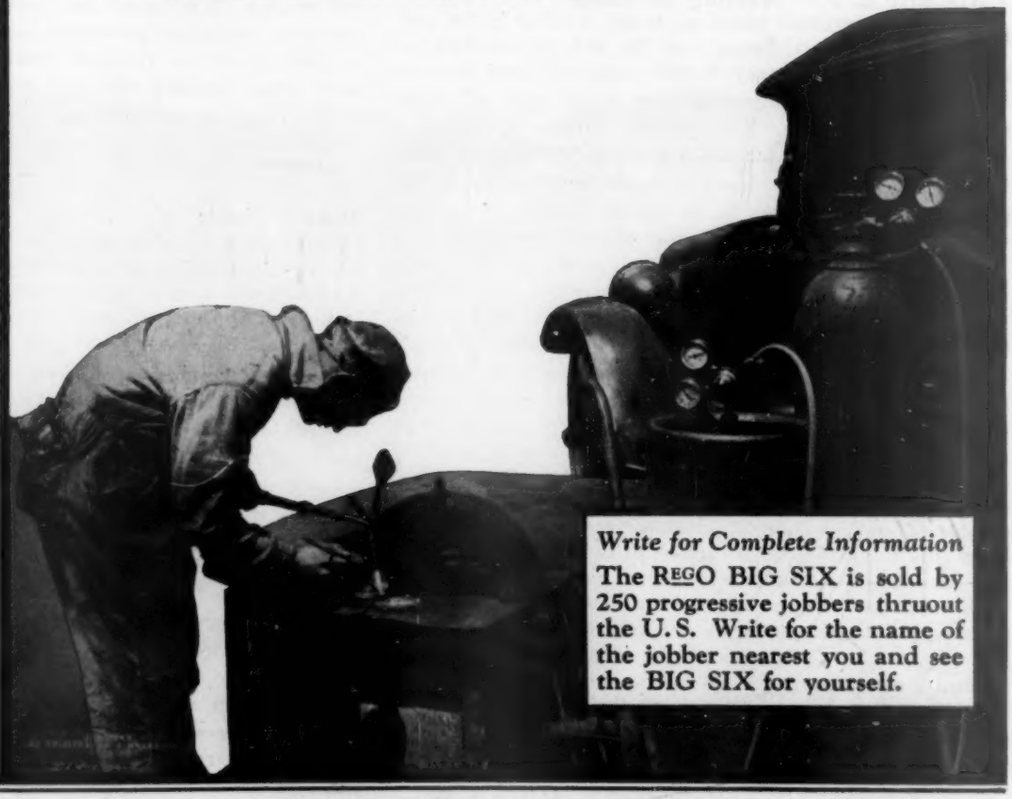

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Aircraft Welding Standards

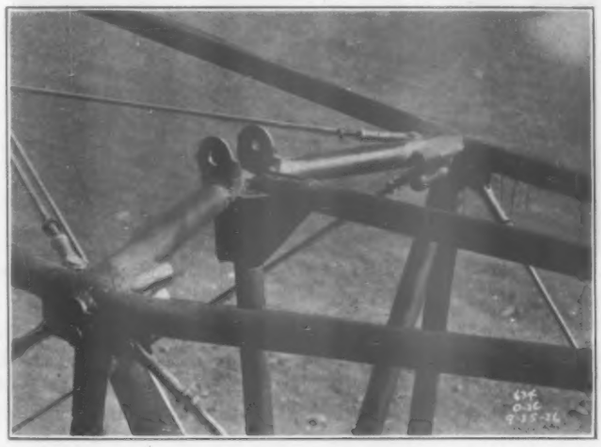
Steel Ships Have Marked Advantages Over Original Wood and Wire Types, But Careful Workmanship Is Necessary to Guarantee Safety

By Miles C. Smith*

Note—In the fabrication of aircraft for the U. S. Army and the U. S. Navy, welding was adopted only after the most exhaustive tests had proven its worth. A great part of these tests were made at the plant of The Douglas Company, Santa Monica, California, and this company's investigations and conclusions as applied to aircraft may be used as well to solve present day problems in all branches of design and construction.—Editor.)

WELDING as practiced at the plant of The Douglas Company, manufacturers of aircraft for the U. S. Army and the U. S. Navy, has resolved itself into a set of standard procedure. The welds must be 100% perfect and must withstand the ravages of service to which they will be subjected. Many factors have been responsible for the adoption of welding in this type of construction and the present methods were arrived at only after a long, tedious series of tests and experiments proved beyond a shadow of a doubt that the conclusions were right and the reasoning sound.

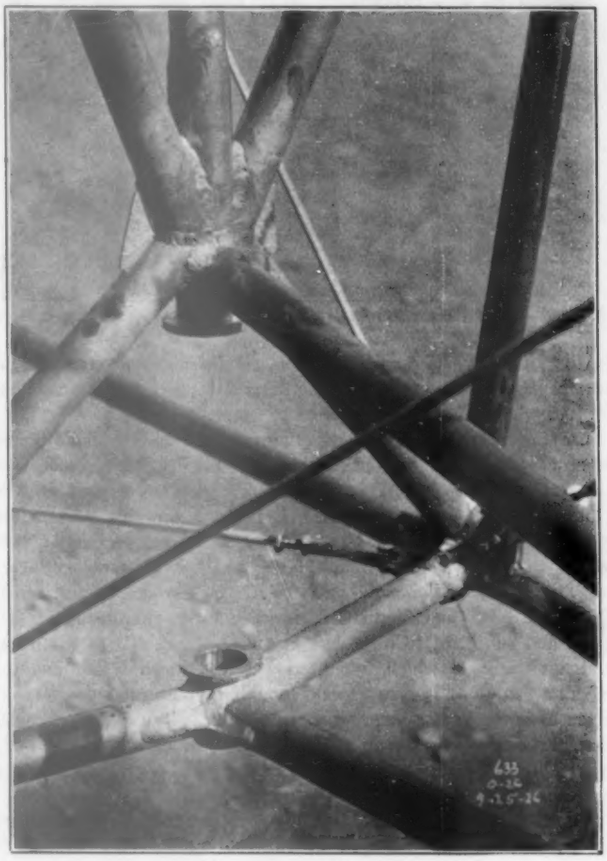
One of the most evident reasons why steel construction was accepted in place of the original wood and wire type of fabrication of aircraft is the growing tendency toward larger ships and the demand for ships which will withstand more severe service. Another reason for steel construction which is perhaps of even more interest to the fabricator of aircraft is the fact that steel ships, particularly if welded, lend themselves to easier repairs and alterations with no sacrifice of strength through the procedure. Splicing in a new member in the frame of a steel ship is a very simple matter where the repairs may be made with a welding torch but in other types of construction the process would not be so simple.



1. Crome-molybdenum Steel Tube Assembly Toward the Rear of the Fuselage Frame, Showing Weld-in Inserts and Method of Anchoring Cross Bracing.

At The Douglas Company's plant two principles are quite evident in all of the welding procedure. First of all, but a single bead is run, thus facilitating a perfect weld and ease of inspection. The other principle adhered to is the acquiring of strength in the welded joint by increasing the linear extent of the weld rather than by piling on metal. For example, when two tubes are joined, end to end, the end of one tube is "fish tailed" and the other tube end slipped inside, then a single bead is run following the line of the "fish tail." In this way three or more times as much linear weld is made than would be made had the tube been cut off with a square end. The same general principle is used in the design of all joints so that as much linear surface is welded as will be necessary to secure the desired strength. The welding is all done with a small oxy-acetylene torch using a No. 1 or a No. 2 tip as the occasion demands; and a soft steel rod is used for a filler. The fabricated members have thin walls and call for careful welding operation.

Before detailing a few of the designs which welding has made possible it is interesting to go back a few years and touch on the work which was done toward the final adoption of the present day construction. In fact, to begin at the time when wood and wire were failing as materials to meet the requirements aerenautical advances were requiring of them; it was then that the engineers and designers began talking metal airplane construction and The Douglas Company pioneered in these developments.



2. View of the Welding-in of Six Tube Members. Also Shows a "Fish Tailed" Tube Joint in One of the Six Members.

Aircraft in general requires a design which will have unusual unit member strength, but at the same time the ship must be as light as possible. To secure these requirements in metal, at first, seemed quite improbable but, as in the case of all new designs in fabrication, the combined efforts of metallurgical and

*Western Manager, The Welding Engineer.

aerenautical engineers have developed three metallic substances which most satisfactorily meet all the necessary requirements and which give promise of fulfilling these requirements for some time to come. The three metals are Aluminum, Duraluminum and Chrome-molybdenum steel and all three of them are used in the present day fabrication of aircraft at the plant of The Douglas Company. Welding is, for the most part, confined to the steel. While the Aluminum is welded in a few instances, the Duraluminum is never welded. Duraluminum is, after several years of manufacture and use, very much of a mystery metal

3. Close-up of a Welded-up Fitting Comprising Several Machined Parts.

in that its properties under various conditions and after various treatments are known and can be depended upon, but beyond that or just why that no one seems to to know.

Chrome-molybdenum steel, in the form of thin walled tubing, is now utilized for the entire skeleton frame of the fuselage of the various types of Army and Navy planes fabricated at The Douglas Company and every joint is welded, but this standard of construction was adopted following the most rigid series of tests which could be conducted and rechecked by both the engineers of The Douglas Company and the U. S. Government Aircraft Divisions. Time after time welds were made and fittings fabricated and subjected to tests, but in each instance it was the metal and not the weld which failed, so welding was accepted and the metallic structure proven strong enough to withstand the service. Even after entire fuselage frames had been fabricated to completion, the engineers wanted to be sure and the completed assembly was subjcted to tests for strength and rigidity against deflection, but each time they proved to be rigid and strong.

The fact that The Douglas Company have in the past and are at the present time engaged in building aircraft for the U. S. Army and the U. S. Navy has been responsible for withholding to some extent the progress they have made but the performance of Army and Navy airplanes speaks for itself and has been responsible for the adoption of similar methods in the fabrication of commercial craft. Welding has been accepted as the one most feasible means of uniting steel members in this type of construction.

In this plant, every assembled unit is made with the aid of jigs or holding frames and the joints are first tacked with the welding torch and then a smooth continuous bead is run at the joint. When assembling the fuselage frame, the longitudinal members are held in a jig of the entire length, breadth and height of the completed fuselage and two or more welders start at the rear of the fuselage assembly and after the cross units have been placed, weld each joint in succession working toward the front, completing the fabrication as they go.

4. Another Welded-up Fitting Comprising Both Stampings and Machined Parts.

The accompanying illustrations show the type and character of welding done at this plant as well as the design of several fittings which have proven to have maximum strength yet minimum weight. Government requirements prohibit the publishing

5. Two Fittings Welded up from Stampings and Machined Parts.

of a completed fuselage as well as many unique construction designs which have been developed, but from the welds illustrated any welder may gather much information applicable to his own line of work. In a general statement it would seem that through

these several years of designing and testing the advisability of welding as a means of joining steel members to acquire strength, lightness of weight and a smooth joint to say nothing of the possibilities of welding in machined inserts, has been proven without any possibility of contradiction.

For those who have, at times, taken steel structure into consideration when welding alloy steel, it will be interesting to note that the Chrome-molybdenum steel tubing used in aircraft fabrication is in the soft annealed state. Soft annealed steel will have no structural change through ordinary welding procedure and may be depended upon for evenness of structure and strength. Furthermore, while the soft annealed tubing may be easily formed or bent cold the fabricated structure is given rigidity and strength against deflection by its own design, cross bracing and welded in fittings.

SOLDERING BY THE OXY-ACETYLENE METHOD

In the plants of manufacturers of various kinds of equipment sold to the general public in large volume, such as automobiles, household refrigerators, oil burners, vacuum cleaners, radio and phonographic apparatus, incubators, window screens, copper radiators, electric motors, brazed brass and high carbon steel pipe, etc., the extent to which soldering is employed by the oxy-acetylene process is most astonishing. A survey of these operations received from the Oxy-Acetylene Committee of the International Acetylene Association classifies them according to the materials used.

There are three forms of solder: Lead, Tin and Antimony, Cadmium-Zinc and Copper-Zinc. The first melts at three hundred degree Fahrenheit, second at seven to eight hundred degrees Fahrenheit and the third at fifteen to sixteen hundred degrees Fahrenheit. In each case the percentages of the metals used in making up the solder alloys vary, with the result that these solders melt at a lower or higher temperature and with a corresponding decrease or increase of strength. Lead, Tin and Antimony solder has an approximate tensile strength of four thousand pounds to the square inch, Cadmium-Zinc solder of fifteen thousand pounds and Copper-Zinc solder of thirty to forty thousand pounds per square inch.

The use of these solders is based upon the principle that almost any metal will surface-alloy with another metal which melts at a higher temperature, provided the surface of the latter metal is chemically clean and is heated to a temperature corresponding to the melting temperature of the solder used. In cases where the base metal is maintained in contact with the molten solder at this correct heat for a period of several minutes, the extent of the penetration of the solder into the base metal is quite remarkable.

In this respect, it would be logical to describe all of the so-called "Bronze Welding" that is spreading so very rapidly today as a species of "hard soldering." When bronze welding cast, malleable and wrought iron, high and low carbon steels, copper, monel metal, aluminum bronze and other metals and alloys that melt at a comparatively high temperature, it is merely necessary to have the weld areas clean and heated to a good red heat only. Then the Tobin Bronze, Manganese Bronze or other filler rods, if melted upon these weld areas, will instantly effect a joint of very high strength.

This process has now been generally adopted for repairing breaks in cast steel locomotive frames. There are locomotives in operation with as many as three so-called "Bronze Welds" in their frames that are hauling long trains of sixty, eighty or one hundred heavily loaded freight cars daily and these bronze welds continue to stand up year after year under such service. It is, therefore evident that the strength of the soldered joint is primarily dependent upon the kind of solder employed in making the joint.

The oxy-acetylene flame has now been largely adopted as a source of heat for the application of these various solders because it possesses great advantages over the old type soldering iron or copper. For some of this work the required heat can be furnished almost instantaneously, thus effecting a great saving in time and more speed in production.

The first reaction in the burning of acetylene with oxygen is the production of carbon monoxide and hydrogen. The hydrogen, burning in the outer starta of the flame, envelops the molten solder and the heated weld area of the base metal protecting them from the oxygen in the surrounding air. This condition enables a skilled operator to obtain practically the maximum strength of the solder used.

In the production of work where the high heat required by welding might cause discoloration or coatings of oxides which would have to be removed before finishes could be applied, joints can be made by the insertion or application of a fluxed solder. Then when the heat of an oxy-acetylene flame is applied, the solder is observed to melt and spread, effecting a quick, clean weld, free from discoloration and desirable in every respect. Such procedure permits the manufacturer of any device to achieve artistic results when it is essential to perfectly match the colors of metals.

It is evident that a wide field exists for all manufacturers of oxygen, acetylene or oxy-acetylene welding equipment who make it a point to search out these hundreds of places where metal articles are being fabricated on a large scale and where soldering is used in the joining of the parts. The remarkable advantages of the oxy-acetylene flame as a source of heat for such work should be demonstrated to these manufacturers.

CAUSES OF BAD WELDS*

1. Long arc, for instance, 3/16" to 1/4" (22 to 25 volts across the arc), when using a 3/32" electrode.

2. Too little or too much current for size of electrode used.

3. Wrong electrode for the work.

4. Wrong polarity at electrode holder.

5. Work not clean.

6. Lack of brushing off scale and dirt, when more than one bead is used.

7. Poor ground, causing arc to break continually.

8. Panel out of adjustment on multiple arcs, causing wide current variations as shown on ammeter.

9. Metal chilled where weld starts. (Bronze and aluminum must be thoroughly heated before starting weld.)

10. On cast iron, work forced too rapidly, which will cause the weld to pull away when cooling, due to contraction strains. Cast iron must be welded slowly.

11. Material not suitable for welding:

(*a*) Certain grades of cast iron (chilled in cooling, or too many impurities).

(*b*) Certain grades of cast and rolled steel (too many impurities).

(*c*) Aluminum casting with zinc content too high. Zinc vaporizes at comparatively low heat, forming gas and causing porous weld).

(*d*) Bronze and brass castings with zinc content too high. (Zinc vaporizes, forming gas and causing porous welds).

12. A long arc will give a burnt and porous appearance and will lack penetration.

**From "Good Welding Essentials," published by Wilson Welder and Metals Co., Hoboken, N. J.*

Arc Welding With Copper Alloys

Bronzes and Other Alloys of Copper Are Extensively Used for Both Production and Repair Work With the Arc

ON account of the low melting point and low electrical resistance of copper and many of its common alloys in commercial use, arc welders who are accustomed to the regular use of the steel electrode have often found it difficult to get a satisfactory result with any of the copper alloys and have come to the conclusion that they do not make satisfactory welding material as far as any of the electric arc processes are concerned. However, there are quite a number of operations which involve the use of copper, brass or bronze which yield a good finished job and also have quite a wide variety of application in different kinds of industrial plants and metal-work establishments. Investigation of the work done in several repair and production plants

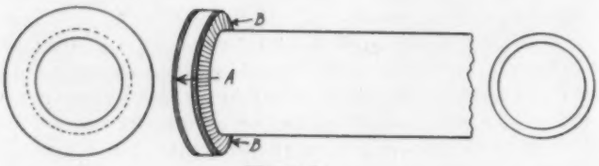


Figure 1.

reveals a few processes which are described below to show the different ways these metals can be used with the electric arc, both in production and repair.

The welding of pure copper electrically has been quite successfully accomplished by the graphite arc method. This makes it possible to use the arc to bring the metal practically to the fusion point before any attempt is made to deposit the metal from the filler rod. A filler rod containing from 92 to 95 per cent copper, 4 to 7 per cent tin and ¼ to ½ of 1 per cent phosphorous makes a good welding material. It is necessary, of course, to use a flux to prevent saturation of the pool with copper oxide. The same filler material can be used as an electrode for welding on copper, but there is not much advantage because some means must

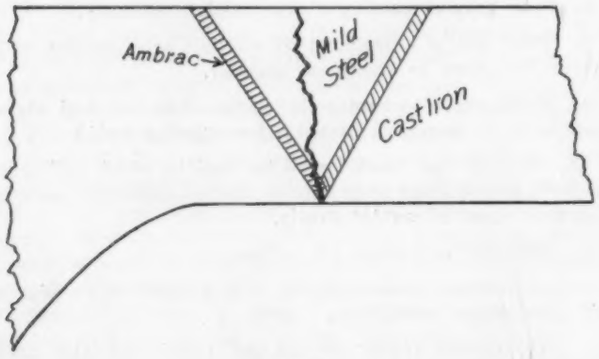


Figure 2.

be available for preheating the copper before starting to deposit metal. Copper welds made in this way can be expected to have a tensile strength of about 20,000 pounds per square inch.

For purposes of comparing this procedure with other methods, a sample of pure copper having a tensile strength of 30,000 pounds was welded using as a filler material a copper-tin alloy having a tensile strength of 47,000 pounds, using a carbon electrode and a current averaging 250 amperes. Two passes were made over one side of a butt joint, adding filler rod, and a third was made with a carbon electrode without adding filler rod. The carbon electrode was then passed over the reverse side of the joint to smooth it up somewhat, no filler rod being added. On a test these welds showed an average tensile strength of a little less than 13,000 pounds per square inch, and examination of the structure of the metal showed it to be quite unsatisfactory. This was undoubtedly due in part to the fact that the portion was *re-heated twice* without adding new metal. A test made at the same time with a phosphorous bronze wire as a positive electrode,

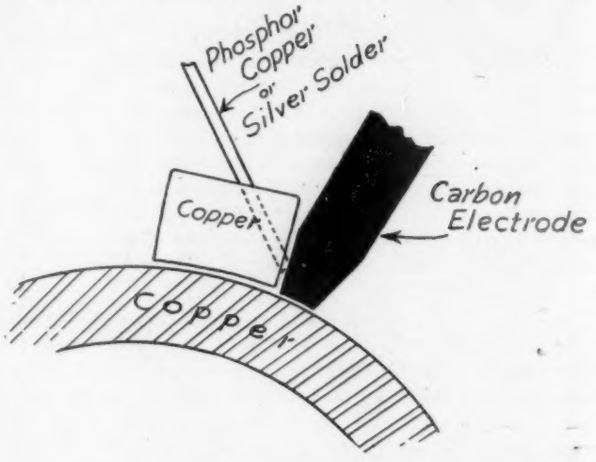


Figure 3.

preheating the work before depositing the layer and depositing a total of three layers to build the weld to the sample, developed a tensile strength of nearly 20,000 pounds per square inch.

It is evident, therefore, that it takes only a few simple experiments to show what a big difference in the result is accomplished by change in materials used and procedure followed. Once the correct procedure is found there is a big field of usefulness for the electric arc in copper and bronze work, a great deal of which is standard practice in some well known plants.

For example, building-up operations have been performed quite

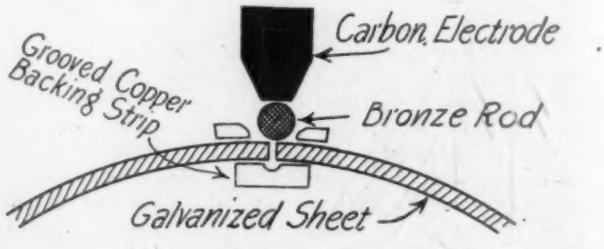


Figure 4.

successfully. A few years ago at one of the welding expositions one of the most interesting exhibits was a working demonstration of metallic arc welding of bronze runners for a large power plant. On account of the size of the parts reclaimed in this case, the savings made possible were spectacular. Reducing this type of work to a job of very small size, we find it in use in the building up of worn bushings, as shown in Figure 1. In this case the carbon arc is used and phosphor bronze is used as a filler rod. These bushings became worn on the face marked "A" in the sketch, and were built up by adding a layer of bronze

then machining down to a smooth surface. An interesting point of procedure was turned up in one plant where this particular repair is standard practice. It was thought that a little time and material could be saved by adding material on the portion of the bushing marked "B" and machining down the worn surface. It was found, however, that the heating effect was not taken into account and bushings repaired in this way failed in service,

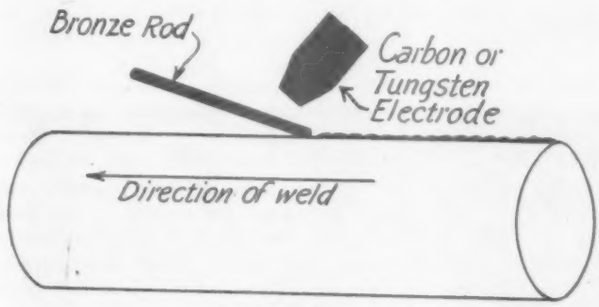


Figure 5.

so the slight saving was not attempted any more.

Another type of repair work which has been the subject of a great deal of experiment is the repair of broken iron castings. There are a number of different kinds of procedure followed for repairing cast iron with either the oxy-acetylene torch or the electric arc. One very interesting type of procedure is illustrated in Figure 2. It is well known that attempts to weld cast iron by the metallic arc process, using a steel electrode, have not been successful. As a substitute for it the procedure of studding and welding is often adopted. The procedure illustrated in the sketch is to first coat the beveled faces of the broken casting with a deposit of Ambrac, a copper-nickel-zinc alloy which unites

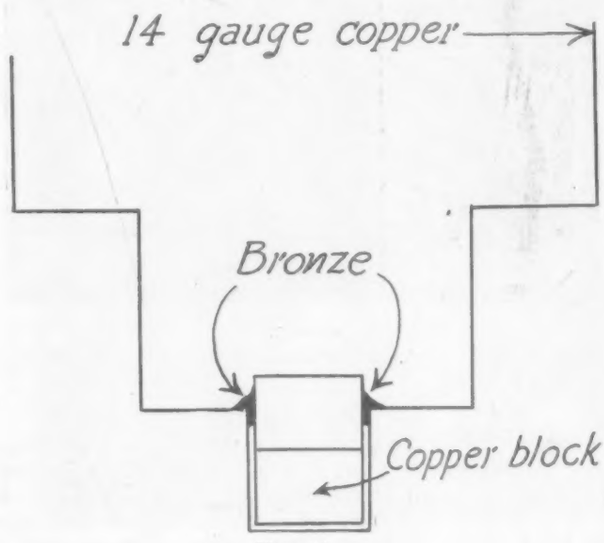


Figure 6.

very readily with cast iron. The zinc in this case acts as an air deoxidizer and prevents oxidation of the metal, the nickel absorbs the excess carbon, the alloy at the same time taking firm hold on the casting. After the latter has been thoroughly coated, it is found that a good high steel electrode will unite with the new surface to make a very strong bond. In the application of the Ambrac electrode the usual polarity of the welding circuit is reversed and a long arc is used. With a 5/32 inch wire, 200 amperes is about the right current. The deposit action takes on more the nature of a spray than ordinary deposit of the metallic steel electrode to which the average welder is accustomed. It should be deposited slowly. When the steel electrode is used to cover the Ambrac, straight polarity with the welding wire negative is used. (5/32 inch wire and 150 amperes). While this method of repairing iron castings is not as common as some of the other methods, it has proven very satisfactory in a number of shops where it has been used. Cast iron water wheels corrode severely where the water leaves the under side of the vanes to pass into the discharge. These surfaces can be coated to advantage by electric welding with Ambrac. Still another of its uses is in the building up by arc welding of defects uncovered when machining castings. The procedure is to continue the machining to dimension, then fill in or build on with the Ambrac and machine or grind to dimension.

Some of the most interesting uses of bronze alloy rods occur in production work. Figure 3 shows, in a general way, a method of using a phosphor copper or a silver solder in connection with an arc welding machine with a technique which cannot really be called arc welding. The diagram represents the application of copper bars to a copper ring in the construction of a commutator. In this case the carbon electrode is placed directly on the copper ring and becomes red hot and thus induces heat in the parts to be joined. This high temperature is sufficient to melt the filler rod of phosphor copper or silver solder so that it will make a strong bond between the bar and the ring. While this method of heating may be new to a number of operators, it is considered quite common in several shops.

Another important production job for the phosphor bronze rod and the carbon arc process is in the fabrication of tanks from galvanized iron sheets. The problem in this case is to get a strong joint without destroying the rust-resisting coating. One method of doing this is shown in Figure 4. Here the sheets are held in a jig so as to almost meet and the bronze rod is laid over the space between the slightly separated edges. The joint is accomplished by drawing a carbon arc from one end of the seam to the other (one-eighth inch wire and 175 amperes current.

Figure 5 shows the operation of this practice in which the bronze rod is held by the operator slightly raised from the horizontal so that it can be manipulated back and forth if necessary to get a good, even weld. The arc is drawn from the carbon to the bronze rod in this case. In some plants the use of tungsten instead of carbon for the electrode is considered to give better results.

It would be difficult to list all of the possible applications of the bronze rod to production work and the job illustrated in Figure 6 is taken as an example of the unusual and unexpected types of work where the process may be found in successful application. The case shown is taken from the procedure of a manufacturer of copper window frames. In these it is necessary to have a small solid copper stud inserted at intervals to hold some of the fastenings. The best way that has been found to do this is to weld around with flux coated phosphor bronze electrode. The job illustrated was done with a one-eighth inch rod and 200 amperes current, polarity reversed. A good strong joint is secured with practically no distortion and the production rate is exceedingly high.

STEEL FRAMING FOR DWELLINGS MAKES BIG ADVANCE

An elaborate booklet recently published by the Steel Frame House Company, Pittsburgh, Pa, which is a subsidiary of the McClintic Marshall Corporation, indicates that the idea of using steel frames for dwellings has been subjected to rapid development which was predicted by industrial papers just a short time ago. There are many arguments in favor of using steel framing for private dwellings, which are carefully set forth in the above mentioned booklet. The booklet also contains artists' drawings and architects' plans of four different types of dwellings, ranging in size from five rooms to eight rooms. It is interesting to note that a great deal of the materials featured in this booklet are welded in the course of manufacture and also that it is possible to use welding in field work in the course of assembly.

Welding Stainless Steels

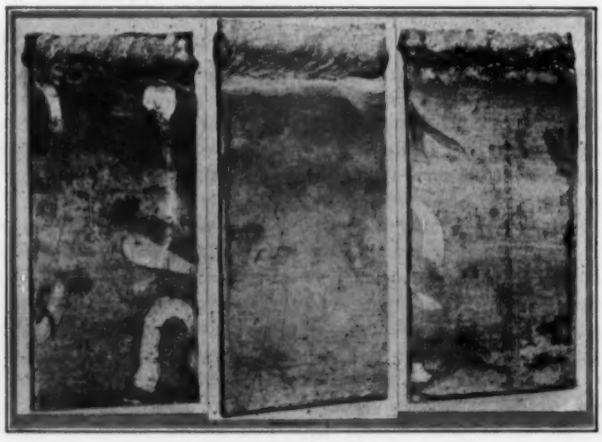
Selection of Parent Metal, Welding and Cutting Process, From the Standpoint of Cost in Commercial Application

By J. B. Green*

IN AN article appearing in *The Welding Engineer* for February, 1928, the author gave a brief survey of the various types of Stainless Steels, indicating their properties with special reference to welding. The article is really a primer outlining the general significance of these chrome-iron alloys and the subject matter must be understood before further study can be made profitable.

It has often been repeated that these alloys can all be readily welded. So they can by the man who knows how, but they are all quite "tricky" and it is decidedly misleading to imply that the matter is as simple as mild steel welding. The fact that chromium is so easily oxidized at welding temperatures only, however, and the resulting chromic oxide so refractory is responsible for the "tricky" features incidental to welding these relatively high chrome alloys.

All of the stainless steels can be both welded and cut by all three of the fusion processes, gas, carbon arc and metallic arc. There will probably always be differences of opinion, all too often inspired by a special interest in, or familiarity with, some one process or alloy, as to just which of the processes or alloys



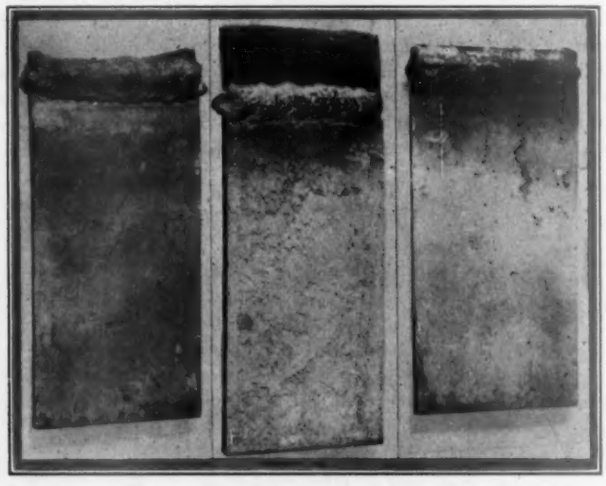
Group I

Welds Made in Non-Austinitic Stainless Steel Bars ¼"x3". Analysis—Chromium 17%, Carbon 0.07%. Left to Right, Oxy-acetylene, Carbon Arc, Metallic Arc.

is best suited for any particular application. Happily, the author's business association and experience gives him as much interest in and experience with one as another. The mere fact that a thing can be done does not necessarily mean that it is a practical commercial application. Thus it would seem to be a duty on the part of those leading the introduction of stainless steel welding into industry to make strong recommendations, keeping in mind the problems faced by the man who must practice stainless steel welding at a profit. When a knowledge of such welding becomes generally scattered, the user can safely be left to form his own judgments.

With the thoughts of the last paragraph in mind, the author recommends that all who consider making welded articles of rolled stainless steel plates, sheets, bars, etc., for the first time, consider only what is known as an air quenching austinitic alloy. There are a great variety of compositions possible in this class but the one now made by several manufacturers has approximately the following analysis: Chromium, 17 per cent to 18 per cent; nickel, 7 per cent to 8 per cent; carbon, 0.25 per cent to 0.25 per cent max. On the same basis, it is recommended that the carbon arc be used for cutting and the metallic arc for welding with either A. W. P. electrodes, imported from England, or Weldite Stainless Electrodes, made by the Fusion Welding Corporation, Chicago, as these are the only two which the author knows are made by welding rod manufacturers, and generally available to the public.

Numerous illustrations accompany this article and they will be referred to in the text more often in groups than individually in explaining the above recommendations. Groups I and II represent welds made in two types from the many non-austinitic



Group II

Welds Made in Non-Austinitic Stainless Steel Bars ¼"x3". Analysis—Chromium 27%, Carbon 0.20%. Left to Right, Oxy-acetylene, Carbon Arc, Metallic Arc.

chrome-iron alloys. Each type in this non-austinitic class has its own characteristics but from the welding standpoint they all have a tendency to develop brittle ranges at or near the edge of the weld. All these illustrations are of test bars substantially twice the length shown which, after being welded, were supported at both ends and hit with a hammer over the weld. They all broke readily. The parts which included the weld after so breaking were photographed. All of these welds were made without preheating, no subsequent annealing or heat treating applied and no fluxes used except the coatings on the metallic arc electrodes. Further examination revealed them all to be good, sound welds and the pictures indicate they all have the appearance of a commercially acceptable product. Note that all three fusion processes, oxy-acetylene, carbon arc and metallic arc are included and, so far as the welding operation only is concerned, successful welds resulted in each case.. Such results certainly make it possible for the advocate of anyone of the fusion methods to truthfully say that all stainless steels can be readily welded by his particular process. To stop here, however, is bound to be very misleading to the man who is not yet familiar with all the ins and outs of

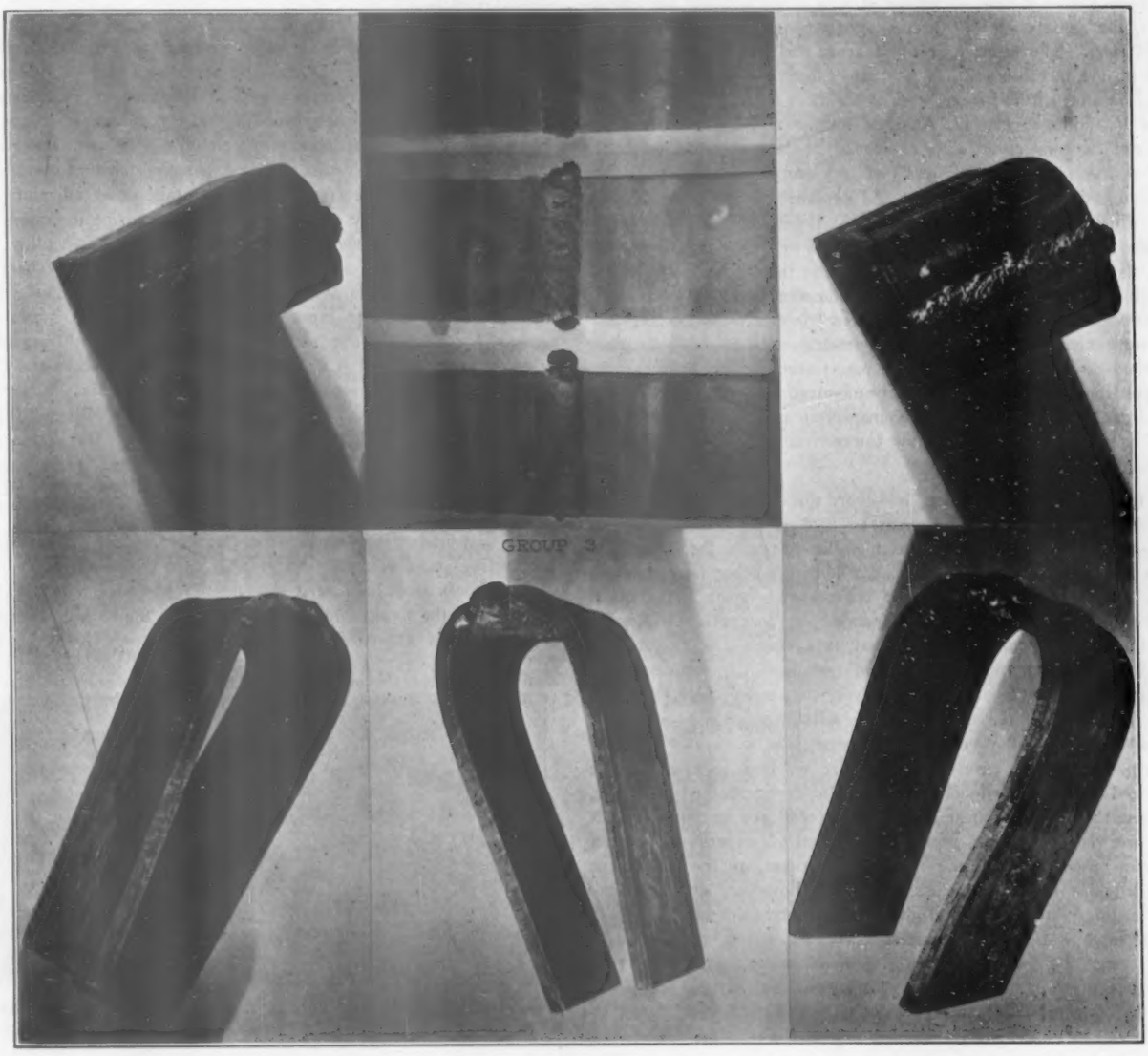
*President, Fusion Welding Corporation, Chicago.

stainless steels and who wants to apply them commercially. Costs are his greatest consideration.

In general, the non-austinitic chrome alloys cost less than the austinitic. By preheating, heat treating, etc., often far better physical properties can be obtained next to the welds than is indicated by the photographs in Groups I and II. The equipment for such treatment is often, if not always, prohibitively expensive to purchase and operate in connection with the manufacture of many articles to which stainless steels are particularly adapted. As a rule, differences in cost as between this or that material or

tries, the austinitic alloys will prove the most practical and cheapest for commercial applications involving welding, because the least special knowledge is required to use them.

The illustrations in Group III are all of test bars of these austinitic alloys similarly made and hammered to those of the preceding groups. Note that no brittle range is in evidence. The bars made by all three processes bend nicely to "U" without any signs even of incipient fracture. This is just what might be expected of an air quenching austinitic steel, the ductility of which usually exceeds by 50 per cent that of the best dead soft annealed mild



Group III

Welds Made in Austinitic Stainless Steel Bars ¼"x3". Analysis—Chromium 17%, Nickel 8%, Carbon 0.12%. Left, top, Oxy-acetylene.—Top View, Left Bottom, Oxy-acetylene.—Side View, Data. Time 180 Seconds, Torch-Fuzon-8C Tip, Welding Rod Consumed 14"x$\frac{1}{16}$". Center, Top, Oxy-acetylene welds showing effect of changing character of flame—Oxializing, Neutral-Carbonizing. Center, Bottom, Carbon Arc—Side View. Data: Time 220 Seconds, Amps. 125, Welding Rod Consumed 20"x$\frac{1}{16}$". Right, Top, Metallic Arc—Side View. Data:Time 120 Seconds, Amps. 110, Welding Rod Consumed 20"x$\frac{1}{16}$".

equipment are relatively small items compared to the cost of repeated commercial experiment and failure which usually is part and parcel of the introduction of new materials and methods to an industry. Some time in the future, men, no doubt, will be available in numbers who are thoroughly familiar with the properties and treatment of stainless steels and then only will it be commercially feasible for those concerned with welding these metals to feel their way one small step at a time toward the use of the cheaper alloys. While the application of stainless steels is still new, generally speaking, to the metal working indus-

steel. Furthermore, it retains this property regardless of heat treatment. It can be heated to any temperature and either slow cooled or plunged in water and it remains austinitic. Its physical properties are only changed by work or other cause of strain which, as usual with metals, increases its strength and reduces its ductility, and by annealing, which has the reverse effect. The point being brought out is that neither heat treatment nor work change the metallographic composition of the alloy as in straight carbon steels which can be hardened, softened and tempered. Fortunately, these austinitic stainless alloys offer, in most appli-

cations, the greatest resistance to corrosion and scaling at elevated temperatures.

Having narrowed the matter down so far as choice of parent metal is concerned, the next consideration is one of the fusion process. The illustrations in Group III show that all three processes result in good welds. The form taken by the bent bars, all similarly tested in forming them to a "U," indicate, as might be expected from our knowledge of mild steel welding, that the oxy-acetylene and carbon arc processes put more heat in the adjacent parent metal than does the metallic arc. The annealing effect on the parent metal is shown clearly in the radius at the bend in each case. Where shrinkage strains from welding are important, the same choice of process governs in this respect as with mild steel. The relative freedom from shrinkage strains through use of the metallic arc has a greater significance than with mild steel because of the higher price of stainless steel and hence greater loss if spoilage occurs. Another matter which should be considered in connection with choice of process is what might be called the relatice "trickiness" of oxy-acetylene and carbon arc as compared with metallic arc. To explain this better, note again the illustrations of Group III. Here three unbent test bars are shown gas welded, the center one with a neutral flame, the rough pitted one with an oxidizing flame, while the smoothest of all on the opposite side is done with a carbonizing flame. The point to be brought out is that the flames were neither pronouncedly oxidizing or reducing, differing from neutral only as much as many torches do while being used at one setting. The difference in the character of the weld is so pronounced that the sort of flame used can be told at a glance by inspecting the finished weld. The carbon arc weld has a tendency toward surface pits which makes it only slightly less tricky.

The real basis of choice, however, goes back to the cost of repeated experiment and failure as it does in the case of the parent metal. Only with the metallic arc are the source of heat and filler material inseparable. With the other two processes they are subject to independent control and hence the skill of the operator must be mainly depended on for results. Neither working welders nor engineers and supervisors are as yet generally acquainted with the required technique for stainless steel welding, and, because it is unusually tricky, many costly attempts will almost surely be required before an organization acquires the knowledge and skill necessary to commercially weld stainless steel at a profit. In the case of metallic arc welding, so much of the required skill can be incorporated in the generator and electrode, because the source of heat and filler material are inseparable, that the user is relieved of most of the cost of experimenting and learning through failure. The manufacturer of the equipment and supplies bears the brunt. He can, however, distribute his cost in this respect over the purchases of a large number of users in the sales price of his products, so that to each it is an insignificant item. This same principle of distributing development cost can be applied in the case of oxy-acelylene and carbon arc welding, but obviously here there is not only the development cost to be distributed, but also of teaching or transferring the knowledge and skill required to each individual operator and supervisor. The author means to be entirely impartial as between the various processes and base his recommendations solely on developed facts. In presenting these facts, he desires to be as careful not to overstate as to understate them. He cannot leave the subject of this paragraph without saying that he does not intend to imply that all the prospective user needs to do is to purchase properly designed equipment and supplies for stainless steel metallic arc welding and no knowledge or skill is required. Much is still necessary. In making a choice as between the processes, all matters are relative. It is a case of which is the best, all things considered, not which is perfect or fool proof. No welding process is fool proof and quite probably none ever will be.

While the cost of acquiring the necessary skill and knowledge should be the main consideration until the welding industry is better acquainted with stainless steels, still it probably is not now too soon to touch briefly on some of the more familiar cost items as labor, filler material, heat, etc. In the case of mild steel, these items in their order of magnitude run generally for gas welding, heat, labor, filler and for electric welding, labor, filler, heat. Furthermore, in gas welding, filler is usually a long third to heat and labor, while in electric, filler and heat together are a long second to labor. On account of the extreme difficulty in drawing austinitic stainless steel wire, which only a very few wire mills and but one regular welding rod manufacturer have so far been able to draw at all, the cost of filler material is relatively important, especially in the smaller size rods. Up to quite recently, the fluxes required for metallic arc electrodes have also been very expensive with the possible exception of calcium fluoride. This latter flux seems to give off appreciable quantities of free fluorine gas in the metallic arc which can be recognized by the "biting" sensation it gives on the mucous membrane of the nose and throat when breathing air in which it is present. There seems to be a difference of opinion among authorities as to the effect of this gas on men, and so it is suggested that users either specify electrodes free from flourides or take other adequate precautions until the toxic action, if any, from fluorine liberated during welding be established. The high cost of the drawn alloy wire has been met for gas and carbon arc welding by using shearings from sheets and plates as filler material. It seems impossible to make these of uniform cross section and so they are practically useless for metallic arc welding. Offsetting any difference in price of filler material is the cost of gas in that process and labor in both the oxy-acetylene and carbon arc processes. Somewhat similar conditions prevail in these respects as with mild steel welding. So little filler material has been used for commercial stainless steel welding that it has not yet reached price equilibrium. Competition, patent monopolies, etc., will take care of the situation in due time as they always do.

The last matter to be discussed is the selection of a process for cutting stainless steel. Safes and bank vaults are often lined with stainless steel because it is generally conceded that it cannot be cut with the oxygen torch. The moment the oxygen is turned on, a layer of almost infusible chromic oxide is formed which immediately stops the action. However, stainless steel can be gas cut if the torch fuses the metal and a non-oxidizing gas blows the molten metal away. Nothing has yet been developed along these lines of a practical nature. Metallic arc electrodes have been made in the author's laboratory which simulate this action and successfully cut stainless steel. Their manufacture, however, on a commercial scale is tricky and expensive, and, as they offer no decided advantages over the carbon arc, they are not on the market. The illustration accompanying this article shows a carbon arc cut made in a piece of austinitic stainless steel. It is not as smooth nor nearly so narrow as oxygen cuts in mild steel, but it is the best fusion cut available today and will fill most requirements. The carbon arc really wins the choice of cutting largely through default of the other two processes. This for the moment leads back to the choice of metallic arc as the welding

Carbon Arc Cut in Steel Having 17% Chromium and 8% Nickel. 300 Amperes, 45 Seconds.

process for stainless steels. Some metallic arc welding generators will also produce a very satisfactory carbon cutting arc but others will not, either because of inherent electrical characteristics or insufficient current output. Sooner or later every prospective user of metallic arc stainless steel welding will want to cut this metal by fusion methods. Care should be exercised, therefore, in purchasing electric welding equipment that only such is selected as is manufactured by those familiar with all the requirements of both welding and cutting stainless steels.

REDUCED RATES ON AIR MAIL ARE EFFECTIVE AUGUST 1

(By Arthur C. Leuder, Postmaster, Chicago, Illinois)

It will cost only one-quarter as much to send the average business or social letter by air mail on and after August 1st as it does now, for on that date the rate will be reduced from ten cents a half ounce to five cents for the first ounce or fraction and ten cents for each succeeding ounce or fraction. This means that an ordinary letter may be sent anywhere in this country for five cents and that an air mail package which now requires $2.00 postage may then be sent to any part of the country for $1.05.

The regulations on air mail are simple. Any mailable matter (except perishable matter liable to damage by freezing) may be sent by air mail. Registered, insured and C. O. D. matter is carried by air mail as are packages not exceeding fifty pounds in weight and not exceeding 84 inches in length and girth combined. Special delivery stamps still further expedite delivery of domestic air mail.

Air mail may be deposited in any mail box, but sufficient time should be allowed for collections and transport to the main post office in time for shipment to the air mail field. Distinctive air mail envelopes are desirable, but not compulsory, but the words "Air Mail" or "Via Air Mail" must be clearly endorsed on the enevelope or wrapper.

This new low rate effective August 1st holds out tremendous possibilities for the American business man. This reduction comes when the air mail companies are giving the most dependable service in their history. The man or woman using air mail for business or social correspondence has the benefits and connections of twenty-eight air mail routes over 12,457 miles, serving 62,000,000 people directly and millions more indirectly. Each twenty-four hours the mail planes fly 24,914 miles and their daily average mail load now exceeds three tons. Air mail averages more than 100 miles per hour and planes are flown night and day in fair or foul weather.

Speed is the essence of air mail service and the record of efficiency established by the air mail in the last ten years, during which time nearly 16,000,000 miles were flown and 302,000,000 letters carried, merits the patronage of every business man and woman.

It behooves every alert business man to instruct his mailing department to determine where and how time and money can be saved by use of air mail. Each day there is some striking instance of how air mail, which means speed, has been profitable to American business. The new rates effective August 1st should popularize this rapidly expanding method of modern transportation.

THE PHILADELPHIA WELDING EXPOSITON

The 1928 fall meeting of the American Welding Society in Philadelphia, October 8th to 12th, promises to set a new record for successful accomplishments. As in the past few years, one of the outstanding features will be the exposition. More than half the space allotted to welding has been applied for largely by those who exhibited previously. It is expected that the exhibit, which is held in co-operation with the American Society for Steel Treating, will attract a gathering of over 75,000 people interested in the treatment and fabrication of metals as this combined convention covers the entire metal working field.

The days during the exposition are now known as National Metal Week. Therefore, nation-wide attention will be focused on this convention.

The exhibit will occupy all the floor space of the Exhibition Hall of the Commercial Museum. Five days will be devoted to displaying to the industrial world the best in welding equipment and supplies, and exhibits of welded products will be an atttractive addition.

Technical meetings and registration will be held at the Bellevue Stratford Hotel in the mornings and at the Exhibition Hall in the afternoon of each day. The Meetings and Paper Committee is preparing an unusually strong program of interesting papers containing new information and findings. In order to derive the real benefit from the presentation of these papers, it is necessary to be present and participate in the discussions which follow the formal presentation of the papers by the authors.

During this convention period thousands of men representing the American Welding Society, the American Society for Steel Treating and the Institute of Metals Division of the Mining and Metallurgical Engineers will be gathered together.

There will be more than 350 exhibitors covering a space of over 90,000 square feet. A good proportion of this space will be devoted to the welding exhibits. A list of the companies to whom space has already been assigned is shown below. Other assignments are being rapidly made.

Company	Space No.
Air Reduction Sales Co.	131-129
Amberican Brass Company	97
American Steel & Wire Co.	98
Bastian Blessing Company	128
Fusion Electric Welding Corp.	137-135
General Electric Company	53-54-55-56-57-58
Gibb Welding Machine Co.	102
K-G Welding & Cutting Co.	88
Lincoln Electric Company	132
Linde Air Products Co.	146-145-109
Metal & Thermit Corp.	89
Page Steel & Wire Company	103
John A. Roebling's Sons Co.	91
R. D. Thomas & Company	100
Torchweld Equipment Co.	176
Transportation Equipment Co.	102-A
Una Welding & Bonding Co.	138
Welding Engineer	87
Westinghouse Electric & Manufacturing Co.	133-134
Wilson Welder & Metals Co.	95

NEW VICTOR APPOINTMENTS IN SOUTHWEST

The Victor Oxy-Acetylene Equipment Company of San Francisco, Calif., announce that they have appointed Mr. A. S. Heasley, manager of the mid-continental district. Mr. Heasley will have his headquarters at Tulsa and will be in charge of the Victor factory warehouse which is separate and independent of the large stock carried by the Welders Supply Company of Tulsa, Oklahoma.

The Welders Supply Company of Tulsa carry their own stock of the complete Victor line for distribution within the state of Oklahoma. The Victor factory stock, under the supervision of Mr. A. S. Heasley is for the sole purpose of facilitating emergency Victor factory shipments to Victor jobbers in the Southwest and mid-continental territories.

Mr. W. L. Porter, with headquarters at Dallas, Texas has been promoted to manager of the Southwestern territory.

G. P. A. Discusses Trade Practices

Principal Subject of Summer Meeting Is Possibility of Improving Business Conditions in the Industry

At its 14th Midsummer meeting, held at The Homestead Hotel, Hot Springs, Virginia, July 10th to 13th, the Gas Products Association devoted particular attention to the subject of "Better Business Through Better Trade Relations." This subject was developed by Dr. Hugh P. Baker, manager of the Trade Association Department of the United States Chamber of Commerce.

The National Chamber's Trade Association Department of which Dr. Hugh P. Baker is the manager, was established recently for the purpose of coordinating the expanding relations of the National Chamber with the more than 400 trade associations in its membership and at the same time to give

Dr. Hugh P. Baker

assistance to the many other industrial groups now laying out their future program of organization. Trade associations, it is pointed out by Dr. Baker, are entering many new fields, opened up by the increasing competition between industrial groups.

"In seeking new and enlarged markets for their members," Dr. Baker eplained, "trade groups are more and more interested in organized effort along lines of standardization resulting in the elimination of excess varieties, uniform cost accounting, helpful statistical information, credit bureau activities, arbitration, etc."

Dr. Baker's departmental activities are also directed toward the promotion of the movement recently initiated by the Chamber looking toward self regulation by business groups, which has as its aim the elimination of economic wastes in every form. Every assistance will be given industry in helping it to do for itself what it needs to have done, particularly in the elimination of trade abuses leading to unfair competition. Where an industry needs outside assistance, the department will cooperate with the Federal Trade Commission and other governmental agencies.

Mr. W. A. Sherman, president of the Magnolia Gas Products Company, Houston, Texas, followed Dr. Baker's talk with a report of the Trade Relations Committee of the Gas Products Association. This Committee has been working industriously since the last midwinter meeting of the Association to formulate a more constructive program of operation for all members, it being the thought of the leading manufacturers of the industry that the service of manufacturers to the public could be greatly improved if standards of practice were adopted which would make possible a closer and more constructive co-operation.

Mr. Sherman's report was followed by a talk by Senator Christie Benet of South Carolina, a member of the Special Committee on Trade Relations of the Chamber of Commerce of the United States. Mr. Christie explained the importance of the viewpoint that basic and fundamental facts are the same for all industries, resulting in a great similarity of problems. These, however, yield to solutions based on the theory that all business men are naturally desirous of maintaining commercial activity on a high standard. He recommended the adoption of definite standards of practice which would eliminate undesirable competitive methods.

The rapid growth of the oxy-acetylene industry has brought it to a point where the volume of work done might easily appear to have reached very closely to the limit. However, cooperative efforts toward development of every possibility of expansion promises to set the limit ahead for a number of years to come. The possibilities in this direction and the splendid opportunities for increased progress were suggested in the opening addres of the President, Mr. C. O. Epperson, of the Compressed Gas Corporation, Denver.

Prominent among the activities of the Gas Products Association in development work is the preparation of a series of motion picture films showing the value of oxy-acetylene welding and cutting to industries and to the general public. Two of these films have already been completed and a third, which is devoted entirely to pipe welding is in course of preparation. Mr. E. D. Findlay, of the Acme Oxy-Acetylene Company, Chicago, presented a report of the Film Committee at the Tuesday afternoon meeting, telling the progress which is being made in the production of this new film, which shows in a way which is easily understandable the great advantages of welding in a field which has adopted it so far to only a limited extent.

Another opportunity for economies in industrial plants and improvements in the manufacture of metal articles is obtained through automatic oxy-acetylene cutting equipment. Equipment for doing this sort of work and methods of applying it so as to accomplish great savings were described by Mr. Henry Hulatt of the Hubar-Jones Corporation at the opening session.

The meeting of the active members of the Association was held early Thursday morning for the purpose of acting on the recommendations of committees and electing directors for the ensuing year. Immediately following the election of the directors the new Board met for the election of officers.

The following officers were elected: President, C. O. Epperson; 1st Vice-President, O. E. Engler; 2nd Vice-President, E. H. Smith; Secretary, Stuart Plumley; Directors, H. B.

Pearson, E. D. Findlay, M. L. Goodrich, A. J. Russell, W. A. Sherman, E. G. Luening, A. R. Robson, O. E. Engler, E. H. Smith, W. F. Verkamp.

The final meeting of the Convention was held Friday morning, July 13th. This opened with a symposium for discussing the subject of pipe welding in buildings.

Following the discussion of pipe welding, a report of the apparatus group was read by Mr. A. J. Fausek, of the Modern Engineering Company, St. Louis. Then followed a series of papers covering the technical aspects of oxygen production, as follows:

"Developments in the Manufacture and Use of Liquid Oxygen Containers in the Past Three Years," L. E. Bedortha, Purox Company, Denver, Colo.

"A Discussion of Methods for Quinquennial Testing of Purging Bottles, Dry Battery Bottles, and Other Cylinders Subject to High Pressure Other Than the Regular Shipping Cylinders," E. G. Luening, Vice-President, Kentucky Oxygen-Hydrogen Co., Louisville, Ky.

"Should Oxygen Be Chemically Dried Before Compressing It Into Cylinders," Dr. J. R. Zwickle, M. E., National Oxygen Company, Chicago, Illinois.

"Factors Involved in Drawing Liquid Oxygen from Plants Designed for the Production of Gaseous Oxygen," James Dunham, Keith Dunham Co., Chicago.

The Program Committee of the Association left the way wide open for all those in attendance to enjoy their stay at Hot Springs. A half day was left open on Wednesday, Thursday and Friday so that those present could take advantage of the many opportunities for recreation which were offered. A special Entertainment Committee arranged a series of golf tournaments for the men and golf and bridge parties for the ladies, all of which were run off on schedule time and were thoroughly enjoyed.

Prize winners of events arranged by the entertainment committee:

Ladies Bridge: First Prize, Mrs. A. R. Robson; Second, Mrs. L. K. Cowie; Low Score, Mrs. T. F. Wettstein.

Ladies Putting Contest: Mrs. H. S. Card.

Men's Informal Best Ball Foursome:

Low Gross Prize, T. F. Wettstein and L. F. Loutrell.

Low Net Prize, F. R. Fetherston and A. R. Robson.

Match Play Handicap against Par: Gibson and Schoenthaler.

Men's Golf Tournament:

First Low Gross, J. C. Taylor.

Second Low Gross, J. T. Butler.

Third Low Gross, B. R. Pearse.

Handicap against Par, L. F. Loutrel.

First Low Net, H. S. Card.

Second Low Net, F. R. Fetherston.

Third Low Net, A. R. Robson.

Minor Trophy, (Presented by Major J. C. Minor to the G. P. A. Must be won two successive years for permanent possession), H. S. Card.

REGISTRATION

Registration

E. M. Sexton, Air Reduction Co.; B. N. Law, Air Reduction Co.; C. D. W. Gibson, Air Reduction Co.; R. F. K. Tothill, National Carbide Co.; W. C. Keeley, Jr., National Carbide Co.; C. E. Pearson, National Carbide Co.; E. C. Ackerman, National Carbide Co.; L. A. Hull, National Carbide Co.; E. D. Findlay, Acme Oxy-Acetylene Co.; F. B. Wilkinson, Logansport Oxygen Co.; Allan Renton, Hawaiian Gas Products Co.; A. F. Jenkins, Alex. Milburn Co.; E. H. Smith, Commercial Gas Co.; H. S. Card, Welding Engineer; A. J. Fausek, Modern Engineering Co.; I. F. Fausek, Modern Engineering Co.; E. J. Flood, Page Steel & Wire Co.; Stuart Plumley, G. P. A.; R. P. Dieckelman, Pressed Steel Tank Co.; W. H. Ballance, Jr., Electrox Co.; W. F. Verkamp, Ohio Valley Oxygen Co.; Henry Hulatt, Hubar-Jones Corp.; James Millholland, Wm. Wharton, Jr., Co.; Chas. L. Gulick; L. F. Loutrel, Shawinigan Products Corp.; H. B. Pearson, Burdett; W. D. Flannery, K-G Welding & Cutting Corp.; W. A. Sherman, Magnolia Gas Products Co.; E. J. Hayden, Linde Air Products Co.; J. A. Taylor, Wm. Wharton, Jr., & Co.; W. C. Swift, American Brass Co.; M. L. Goodrich, Swift & Co.; C. O. Epperson, Compressed Gas Corp.; Joseph Halla, National Gauge & Equipment Co.; Harrison Bird, Burdett; O. E. Engler, Balbach Company; J. A. Janney, Jr., Philadelphia; E. C. Smith, Harrisburg Pipe & Pipe Bend. Co.; E. C. Frey, Harrisburg Pipe & Pipe Bend. Co.; C. W. Brown, Innis Speiden & Co.; Henry Booth, Shawinigan; W. P. Chur, Shawinigan; F. T. Wettstein, Shawinigan; F. N. Williams, Federal Carbide; V. G. Bartram, Canada Carbide Co.; H. G. Commons, California Compressed Gas Co.; John D. Swain, Union Carbide Co.; A. J. Russell, Bettendorf Oxygen-Hydrogen Co.; David Ahidin, Keith Dunham Co.; D. B. Currie, Page Steel & Wire Co.; L. O. Geiger, Air Reduction Sales Co.; Hugh P. Baker, U. S. Chamber of Commerce; H. Merker, Pressed Steel Tank Co.; W. W. Barnes, Air Reduction Sales Co.; W. S. Schoenthaler, Air Reduction Sales Co.; J. A. Warfel, Air Reduction Sales Co.; H. M. Macauley, Grand Rapids Welding Supply Co.; E. S. Wilkins, Magnolia Gas Products Co.; J. T. Butler, Burdett Oxygen Co.; W. F. McKay, International Oxygen Co.; B. R. Pearse, Atlas Foundry Co.; F. R. Fetherston, Compressed Gas Mfgrs. Assn.; L. K. Cowie; Christie Benet, U. S. Chamber of Commerce; J. M. Cameron, Imperial Brass Mfg. Co.; E. G. Luening, Kentucky Oxygen Hydrogen Co.; M. E. White, Burdett Oxygen Co.; L. M. Goodrich; A. R. Robson, Paschall Oxygen Co.; F. S. Austin, Carbo-Oxygen Co.; J. C. Taylor, Wm. Wharton, Jr., & Co.; J. Milholland, Wm. Wharton, Jr., & Co.; G. H. Verkamp, Ohio Valley Oxygen Co.; L. K. Cowie, Federal Carbide Co.; G. N. Lindsay, Union Carbide Co.; James Dunham, Keith Dunham Co.; C. E. Scullin, Electrox Co.; W. F. Kuhl, Shawinigan Products Corp.; R. Verkamp, Ohio Valley Oxygen Co.; Stanley Winger, Gas Products Co.

Ladies

Mrs. F. T. Wettstein, Mrs. A. Roy Robson, Mrs. C. L. Gulich, Mrs. Stuart Plumley, Mrs. Allen Renton, Mrs. M. E. White, Mrs. C. O. Epperson, Miss Alvina Epperson, Miss Louise Epperson, Miss Marian Epperson, Mrs. H. M. McCauley, Mrs. Harrison Bird and son, Mrs. E. J. Flood, Mrs. A. F. Jenkins, Mrs. H. S. Card, Miss Marian Card, Mrs. A. F. Wall, Mrs. Bodein, Mrs. E. H. Smith, Mrs. L. K. Cowie, Mrs. F. R. Fetherston, Miss Beatrice Bodein.

MAXIMUM ALLOWABLE UNIT WORKING STRESSES FOR FUSION-WELDED JOINTS*

The question as to what unit working stresses should be allowed for fusion-welded joints of pressure vessels has been under consideration for several years. Par. U-68 of the Code of Unfired Pressure Vessels specifies 5600 lb. per sq. in. for the limits of size and working pressure of vessels named therein. In specifying the working stress of 5600 lb. per sq. in. for fusion-welded joints, the Boiler Code Committee leaned toward the side of safety with the idea of broadening out the rules as the art advanced rather than to reach out too far at the start with the risk of accidents. There is a feeling on the part of many that a higher working stress should be used with certain types of joints, and that there should be different types of joints and some way of differentiating between different qualities of fusion welding.

A comprehensive series of tests of welded pressure vessels was carried out by the American Bureau of Welding about five years ago with a view to assisting the Boiler Code Committee in its study of this problem. The data obtained from those tests were of material benefit in establishing desired information, but certain types were not included in those investigations and further studies were found to be necessary in order to codify the practice of fusion welding so that not only good results in joining metals will be insured, but also a rating of stress may be assigned to any welded joint, depending upon its soundness and dependability.

The committee is now in position to announce that studies under way in cooperation with the American Welding Society give promise of the early development of a welding procedure suitable for embodiment in a code that will, if followed, insure safe pressure vessels, and that in addition there has been submitted to it a proposed method of evaluating the welded joint on the basis of tests made of representative specimens thereof. With a view to obtaining discussion and constructive suggestions thereon, the latter method is herewith submitted for the information of every one interested, as follows:

It has been proposed to interrelate in a suitable formula the ultimate strength and the elongation obtained by free and unrestricted bend of sample test specimens of the welded joint. This formula which attempts to give due credit to the ductility factor in the welded joint is as follows:

**These formulas are published in the July, 1928, issue of Mechanical Engineering for public criticism at the suggestion of the A.S.M.E. Boiler Code Committee.*

$$S = \frac{T}{7.15}\sqrt{\frac{E}{10}}$$

where S = maximum allowable working fiber stress, lb. per sq. in.

T = ultimate tensile strength, lb. per sq. in.

E = elongation, in per cent, shown by test specimen subjected to free and unrestricted bending.[2]

The stress determined by the formula should be the maximum stress allowed in the structure. Particular attention should be paid to conditions where this maximum stress may be actually greater than often considered, as in lap or corner joint, if it is desired to apply the formula.

The above formula is based on the general agreement by engineers engaged in the design and fabrication of general steel construction, that a certain amount of ductility is necessary for the safety of any structure subjected to unknown stresses. There is no definite knowledge of the exact amount of ductility needed for any particular case, but information is of course available that certain structures built of material having a certain definite ductility, have proven safe, whereas structures built of materials of low ductility have not shown as consistent results. In ordinary construction work the factor of safety, which has generally been taken as 5, has been based on the fact that there is a certain amount of elongation.

The applicability of this formula is based to a large extent on the newly devised method of determining the ductility of metals by the free and unrestricted bend-test method that substitutes for the usual methods of bending a specimen around a pin or forcing it between two anvil blocks, the most accurate plan of placing a kinked specimen between the jaws of a vise or in a testing machine so that it will bend freely to a U shape. This method, which gives consistent results, produces an elongation in the outside fibers of the specimen that can be measured directly with a flexible scale, and eliminates the uncertainties of measurement of the bend angle which was formerly used as the criterion. With this method any gage length may be used, but one which takes in the width of the weld appears to be most logical for this purpose as it gives a direct measure of the elongation in, and therefore the ductility of, the weld metal.

Inasmuch as it is the purpose in rating welded joints to obtain a measure of the ductility of the weld metal proper, both the tensile and bend tests, as made for this determination, are applied to specimens with the weld reinforcement ground off. In the application of this formula there is no need to be concerned with what may be accomplished in strengthening a weld by reinforcement, as if a welded specimen with no reinforcement breaks outside of the weld, it will be obvious that the weld is stronger than the plate. The ductility of the welds will vary with the welding rod and the process, but it seems reasonable that if two welds, made by different processes or with different rods, have the same tensile strength and ductility, they should be allowed the same working fiber stress.

In developing the above formula the ductility factor was so incorporated that a lower working fiber stress will be allowed where the material has low ductility, and the working fiber stress will depend directly upon the tensile strength. Using varying values for the factors T and E in the formula, tables of proposed maximum allowable working fiber stresses in pounds per square inch of plate section for welded steel pressure vessels have been prepared. The first table represents the manner in which the formula was first worked out to determine its practicability of application to ordinary working conditions, but Table 2 shows the form in which the calculations will probably be most convenient for ordinary use.

The factor of safety in the last column of Table I is the same for any given percentage of elongation. The ultimate strength is either that of the weld metal if the weld breaks during the test, or of the base metal if the fracture occurs in it, and obviously a structure cannot be designed, as far as tensile strength is concerned, except on the strength of the weakest part. It is easily worked out that a factor of safety of 5 is reached at an elongation of somewhat over 29 per cent.

TABLE 1. PROPOSED MAXIMUM ALLOWABLE WORKING FIBER STRESSES IN LB. PER SQ. IN. OF PLATE SECTION FOR WELDED STEEL PRESSURE VESSELS

Per cent elongation by bend test	Ultimate strength in 1000 lb. per sq. in. 45	50	55	60	65	70	75	Factor of safety
5	5,000	5,800	6,100	6,700	7,200	7,800	8,300	9
7½	5,800	6,400	7,000	7,700	8,300	8,900	9,600	7.8
10	6,300	7,000	7,700	8,400	9,100	9,800	10,500	7.15
12½	6,800	7,600	8,300	9,000	9,800	10,500	11,300	6.65
15	7,200	8,000	8,800	9,600	10,400	11,100	12,000	6.25
17½	7,600	8,400	9,300	10,100	11,000	11,700	12,700	5.9
20	8,000	8,800	9,700	10,600	11,400	12,300	13,200	5.7
22½	8,300	9,200	10,100	11,000	11,800	12,800	13,700	5.5
25	8,600	9,500	10,500	11,400	12,400	13,200	14,200	5.3

TABLE 2

Per cent elongation by bend test	Ultimate strength in 1000 lb. per sq. in. Over 45 up to 50	Over 50 up to 55	Over 55 up to 60	Over 60 up to 65	Over 65 up to 70	Over 70 up to 75	Over 75
5 to 7½	5,400	6,000	6,500	7,200	7,700	8,300	8,900
Over 7½ to 10	6,000	6,700	7,300	8,000	8,700	9,300	10,000
Over 10 to 12½	6,500	7,300	8,000	8,700	9,400	10,100	10,900
Over 12½ to 15	7,000	7,800	8,500	9,300	10,100	10,800	11,600
Over 15 to 17½	7,400	8,200	9,000	9,800	10,700	11,400	12,300
Over 17½ to 20	7,800	8,600	9,500	10,300	11,200	12,000	12,900
Over 20 to 22½	8,200	9,100	9,900	10,800	11,600	12,500	13,400
Over 22½ to 25	8,500	9,400	10,300	11,200	12,100	13,000	13,900

It will be observed that the part of the formula covering the factor of elongation decreases the allowable working fiber stress more rapidly than the elongation decreases, and on the other hand increases the fiber stress more slowly than the elongation. This seems quite logical, because there must be a point beyond which an increase in elongation increases the value of the metal but slightly, and because as the brittleness increases, the metal becomes less reliable in service.

For the purpose of applying this formula or the above tables to a specific tank in order that the welds therein may be rated as to allowable working stress, it is proposed that the tensile and bend-test specimens be prepared from samples of plate that are identical with the material to be used in the pressure vessel under consideration, and welded with the same filler rod and type of joint as are to be therein used. The sample of the plate is then to be cut into strips 2 or 2½ in. wide, extending at right angles to the welded joint, so that the weld metal in the joint can be subjected to either the tensile or the bend test. The tensile and bend tests shall be recorded in the manufacturer's data report form under items 8 and 9 covering joints. These figures of the ultimate strength in pounds and the elongation in per cent, when applied to the table, give directly the allowable unit working stress on the vessel in which the joint is used.

[2] *See paper by A. B. Kinzel read at the September, 1927, meeting of the American Welding Society, at Detroit, Michigan; also paper by W. B. Miller, read at the same meeting.*

EROSION OF WATER-WHEEL NOZZLES REDUCED WITH STELLITE

Another interesting use for Stellite has been found. The rapid erosion of impulse water-wheel nozzles in high-head plants has always been a troublesome problem, and maintenance costs run high. At one of the power plants in California, the water passes through a 7⅛-inch nozzle with a velocity of 360 feet per second under an effective head of 2243 feet. The bronze or cast-steel nozzles have had a life of only from thirty-five to forty days, in spite of the fact that the water is clean and free from abrasive materials. By welding Stellite wearing surfaces to the cast-steel nozzles, the effect of erosion by the water has been reduced to such an extent that no signs of it were found on the main water-wheel nozzles after two months of service, nor on the exciter-wheel nozzles after six months of operation. (*From July, 1928, issue of Machinery.*)

Bronze Aids Many Industries

Typical Applications of Welding With Bronze Which Solved Baffling Problems in a Variety of Industrial Plants

HOW oxy-acetylene welders are using the bronze welding rod to improve the construction of metal products and make huge savings through repair of worn and broken equipment is indicated in a series of articles which have recently appeared in the International Acetylene Association Forum, a department of the *Acetylene Journal*, which records the activities of the I. A. A., and publishes communications from members telling of important developments in the uses of acetylene. The following excerpts from technical articles in the Forum will prove interesting to those who are looking for bronze welding information.

Broken Castings Repaired the Same Day

The practicability of bronze welding and its possibilities as an important factor in making quick repairs to heavy duty machinery are made evident in the accompanying illustrations, Figures 1 and 2. The small and the large parts, Figure 2, fit together to form an upright pedestal that holds the sprocket bearings for a No. 49 30,000-pound chain draw bench. While operating, the chain broke, piled up under the sprocket, raised the shaft, and of course tore apart the cast iron shaft support plates.

A similar break that occurred in the past tied up this draw-bench for ten days until a new part could be cast and delivered from the foundry. As an illustration of the remarkable saving in time and money that Tobin Bronze and oxy-acetylene welding are accomplishing, these two broken castings were completely welded on the same day of the break, and returned to the draw-bench stronger than before, and ready for reinstallation. The method of preparation and welding procedure follows:

Fig. 1. The Fractured Parts Were Prepared for Welding by Chiseling a Vee About Two-thirds the Depth of the Crack Throughout the Line of the Break.

The fractured parts were prepared for welding with Tobin Bronze by chiseling a vee about two-thirds the depth of the crack throughout the line of break. This was done in order to allow for a bond of sufficient strength to thoroughly unite the broken sections. The entire time spent in preparation of the two parts for welding, using up-to-date equipment, was about two hours.

Many welders grind down the welding areas before making a bronze weld. Practical experience and many tests, however, bear out the conclusion that a chipped surface provides a better bond of the weld metal because the free carbon that exists in gray iron is not smeared over the welding surface as is the case when ground with an emery wheel.

The long casting with the smaller break was welded by two men in one and one-half hours, using two oxy-acetylene torches, one to heat the castings ahead of the weld, and the other to melt the rod and do the actual welding. It was unnecessary to do any preheating on either casting other than to apply the inner cone of the torch flames on and adjacent to the welding surfaces for a few minutes before starting the weld.

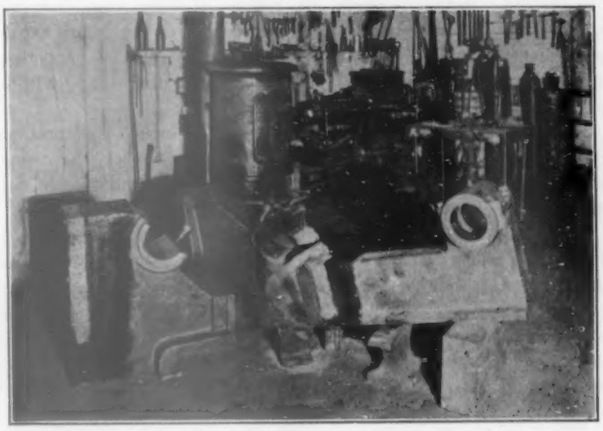


Fig. 2. These Broken Castings Were Completely Welded on the Same Day of the Break, and Returned to the Drawbench Stronger Than Ever, and Ready for Reinstallation.

Had the welds been made with cast iron rods, the story would have been entirely different since fusion welding would have necessitated preheating the castings for several hours in either a charcoal or a gas fire in order to minimize the danger of warping or cracking under the high heat. The actual welding time would also have been considerably increased.

With the welding areas at a good red heat the surfaces were "tinned" nicely with bronze and the weld was built up rapidly. Care was taken not to apply the inner cone of the flame directly upon the Tobin Bronze rod, the outer flame or envelope being used to melt the bronze. The inner cone if applied to the rod has a tendency to burn the bronze, thereby affecting the strength of the weld.

The long casting was welded with 90 cubic feet of oxygen and 90 cubic feet of acetylene and 6 pounds of ¼-inch Tobin Bronze welding rods. The short casting with the longer break was welded in two hours by two men in the same manner as described for welding the larger casting, using 118 cubic feet of oxygen and 118 cubic feet of acetylene and 10 pounds of ¼-inch Tobin Bronze welding rods.

Mr. Charles Gallo of the J. L. White Co., Inc., Waterbury, Conn., who did the work described above, states:

"Such examples as these typically illustrate the advantage of bronze welding to industries employing cast iron machine parts. With Tobin Bronze it is possible to make speedy and efficient repairs to parts that would otherwise be scrapped, and seriously retard production, due to loss of time awaiting the arrival of new parts. Then, too, the bronze weld when properly applied is always twice as strong as the cast iron."

Non-ferrous Range Boilers

The Copper & Brass Research Association, also the American Brass Company, the Chase Companies, Inc., and the Mueller Brass Company have spent, are spending, and will continue to spend large sums of money in promoting the use of brass and copper pipe in water service in homes, apartment buildings, hotels and office buildings. These efforts to increase the use of brass and copper pipe have been remarkably successful, and today there are probably three or four times as much brass pipe going into buildings, and copper pipe being used for service from street mains to buildings as was being used three or four years ago.

Brass and copper pipe are being used, of course, because of their corrosion-resisting qualities. Unfortunately, however, the water supply of many cities is so corrosive that even though brass pipe is installed in the buildings, rusty water continues to run at the spigots. This is due to the rapid corrosion of the steel range boilers and hot water supply tanks. It, therefore, becomes essential that range boilers and supply tanks to be used in connection with installations of brass pipe shall be made of rust-resisting metal. Copper, of course, is quite ideal for this service, but in many cities the water pressures employed are so high that unusually heavy gauges of copper must be employed to withstand these high pressures and insure that there will be no bursting of range boilers and tanks.

Some manufacturers have endeavored to meet this problem by building two tanks, one of steel and one of copper, the copper tank being fitted within the steel tank. This doubles labor cost and increases the material cost.

The Du Pont Company had the problem, a few years ago, of finding an alloy that would resist corrosion of most acids and alakalis and still have the strength of steel, and, as a result of a long series of experiments, developed an alloy named "Everdur." This alloy, which is 96 per cent copper, 3 per cent silicon, and 1 per cent manganese, is as corrosive resisting as copper and is 15 to 25 per cent stronger than mild and low-carbon steel. This alloy, therefore, makes an ideal material for range boiler and hot water supply tank work because it can be welded by the oxy-acetylene process quite as readily as good steel. "Everdur" sheets are welded with "Everdur" welding rods.

This development opens up to oxy-acetylene welders a new and most promising field for the use of oxy-acetylene welding in the fabrication of range and tanks to be used in connection with brass and copper pipe installations.

Copper Screens

After many years of use of iron, galvanized iron, and copper wire, each of these materials has failed for one reason or another to serve successfully as a screen material. Iron wire screen, of course, requires yearly painting to give it even brief existence, while in some climates the life of the galvanized iron wire screen is almost as brief. Copper wire cloth resists rust in most climates with entire success, but its strength is insufficient to give satisfactory service. The use of bronze wire cloth, which is merely a strengthened copper, has been the solution of the problem of obtaining the right material for screens.

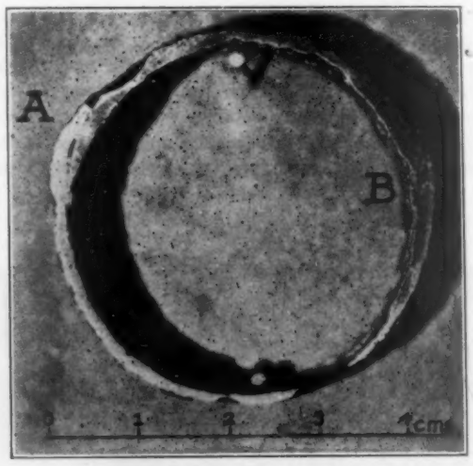
Then arose the problem of a permanent frame for a permanent screen. This has been solved by the introduction and use of a frame fabricated from a material corresponding to the wire used in the cloth, the most satisfactory of these materials being what is known as commercial bronze and red brass. The former is an alloy of 90 per cent copper and 10 per cent zinc, and the latter is 85 per cent copper and 15 per cent zinc. Red brass, having a lighter color, finishes up to harmonize better with the cloth and also as a rule with the color of paint generally used on residences and apartment houses than the other.

Because red brass and commercial bronze contain zinc, it is difficult to make the joints by spot welding as can be done when galvanized iron or steel is used for the frame material. It, therefore, is necessary to use the oxy-acetylene process in welding these screen frames, and entire success in this work is made easily possible by using the smallest size welding torch, producing a flame having a cone about the size of a lead pencil point, and filler rods known as Tobin or manganese bronzes. These welding rods are alloys of copper and zinc, in each case of approximately 60 per cent copper and 40 per cent zinc. The alloys differ in that Tobin bronze contains 1 per cent tin, and manganese bronze 1 per cent each of iron and manganese. Being high in zinc as compared with the red brass and commercial bronze used in the frame materials, these welding rods melt at a much lower temperature so that in making the welds it is not necessary to melt the red brass or commercial bronze but only to bring them up to a dull red heat and melt the Tobin and manganese bronze on the heated surface. A good brazing flux is essential in this work.

By following the foregoing suggestions, any good oxy-acetylene welder should be able to make neat and rapid work in the fabrication of permanent screen frames. When discoloration of the metal must be avoided these frames may have to be soldered instead of brazed or welded. A very quick and neat job of soldering is possible by the use of the oxy-acetylene torch. Some manufacturers use dozens of oxy-acetylene torches in soldering with very great advantages over other forms of heat.

FERRULE WELDED FIFTEEN CENTURIES AGO UNEARTHED IN ENGLAND

That soldering, brazing, and welding were not unknown in Britain as early as the fourth century A. D. is evidenced by an example of Roman welding dug up on the site of the Roman city of Uriconium, which flourished on the banks of the river



Ferrule Welded in Fourth Century A. D.

Severn until A. D. 380. The discovery is reported in a recent bulletin of The Institute of Metals, London.

A cursory examination showed the specimen to be one of exceptional interest, for not only does it prove that the Romans in that country were able to weld iron, but it is the first authenticated example of the joining of two pieces of iron with copper—the forerunner of modern brazing.

On rubbing down the ends it was clear that the ring was made of two rectangular strips of metal bent into half circles, welded together at one edge B, and copper welded on the other, A, where the metal has been tapered, freed from oxide, and very neatly joined. With the exception of one side of the copper joint, there was no suggestion of overheating, but one edge of the weld, B, was separated by a mass of slag and oxide, although apparently perfect fusion was obtained on the other edge.

SAFE PRACTICE RECOMMENDATIONS

The Department of Labor & Industry of the commonwealth of Pennsylvania publish a pamphlet, "Safe Practice Recommendations" which includes those pertaining to compressed gases. Rules are suggested to cover permanent piping of oxygen, acetylene and similar installations; care of containers; and handling and storage of containers.

C. G. M. A. SUMMER MEETING

The Compressed Gas Manufacturers Association met at the Seaview Golf Club, Absecon, N. J., for their annual summer meeting, on June 21, 22 and 23. The meeting was attended by executives representative of the various compressed gas industries.

On the evening of June 21st a number of committee meetings were held, foremost of which were the Finance Committee, Insurance Committee, and a committee composed of manufacturers of gases used in the refrigeration industries.

On Friday evening, June 22nd, the regular Executive Board meeting was held, President H. S. Smith, of the Prest-O-Lite Co., Inc., in the chair. Among the gentlemen who spoke at the gathering were Allan Renton of the Hawaiian Gas Products Co., Honolulu, Hawaii, Mr. C. L. Kerr, Rockgas Products Co., Mr. H. M. Mabey, Mathieson Alkali Works, Inc., Mr. L. F. Loutrel, Shawinigan Products Co., and President H. S. Smith.

Future meetings of the Executive Board were postponed until September.

The subject that occupied a prominent position on the agenda of the meeting was the discussion of the recommendations presented by the Transportation Committee with regard to the petition being filed by the Association on behalf of its members, protesting to the Interstate Commerce Commission against the increased freight rates in Southwestern Territory on empty returned gas cylinders.

Following the business meeting presentation of the awards for the golf tournament held during the convention were made: The Challenge Cup presented by President H. S. Smith was won by Mr. L. F. Loutrel of the Shawinigan Products Company. This trophy must be won three times to become the permanent property of a contestant. There were fourteen other awards made.

The members attending the convention were:

W. C. Keeley, National Carbide Co.; C. B. Armstrong, National Carbide Co.; C. H. Stevens, National Carbide Co.; J. J. Crowe, Air Reduction Co.; R. B. Davidson, Air Reduction Co.; R. A. Sossong, Air Reduction Co.;; E. C. Turner Air Reduction Co.; J. R. Eldridge, Virginia Smelting Co.; Col. G. E. Carleton, Bureau of Explosives; H. M. Hooker, Hooker Electrochemical Co.; R. W. Hooker, Hooker Electrochemical Co.; R. E. Bruckner, National Gauge & Equipment Co.; C. C. Trees, Carbo-Hydrogen Co. of America; F. S. Austin, Carbo-Hydrogen Co. of America; L. W. Hench, American Oxygen Service Co.; C. L. Gulick, R. W. Quinn, Mathieson Alkali Works, Inc., H. M. Mabey, Mathieson Alkali Works, Inc.; A. E. Hooker, Mathieson Alkali Works, Inc.; C. E. Cooper, C. E. Cooper & Co.; R. D. Brooks, Worthington Pump & Machinery Co.; P. F. Lavedan, Liquid Carbonic Co.; H. L. Cook, Liquid Carbonic Co.; N. E. Bartlett, Pennsylvania Salt Mfg. Co.; Eugen Becher, Metal & Thermit Co.' H. W. Cole, General Carbonic Co.; G. O. Carlson; H. W. Smead, Compressed Carbonic Co.; Henry Bower, Hy. Bower Chem. Mfg. Co.; E. Rowland, Hy. Bower Chem. Mfg. Co.; W. W. Robertson, Armour Ammonia Works; H. S. Smith, Prest-O-Lite Co., Inc.; P. Samuel Rigney, Roessler & Hasslacher Chem. Co.; L. F. Loutrel, Shawinigan Products Co.; Otto S. King, Ohio Chem. & Mfg. Co.; A. Roy Robson, Paschall Oxygen Co. F. J. King, Linde Air Products Co.; E. A. Doyle, Linde Air Products Co.; H. D. Edwards, Linde Air Products Co.; Dr. C. L. Jones, C. R. Edwards, Prest-O-Lite Co., Inc.; W. B. Campbell, Phillips Petroleum Co.; L. A. Belding, American Welding Co.; Allan Renton, Hawaiian Gas Products Co.; L. E. Bedortha, Purox Company; W. S. Shoenthaler, Air Reduction Co.; C. L. Kerr, Rockgas Products Co.; L. A. Hull, National Carbide Co.; L. Bowen, Liquid Carbonic Co.; F. A. Savage, Liquid Carbonic Co.; R. R. Browning, Linde Air Products Co.; G. B. Walker, Linde Air Products Co.; G. P. Bogert, Dominion Oxygen Co., Ltd.; F. R. Fetherston, C. G. M. A.

McKIBBEN LISTS WELDED STRUCTURES

A total of 85 welded structures, including 43 welded buildings, is listed by Professor Frank P. McKibben in the July issue of the General Electric Review. The list is made up of 8 bridges, 43 buildings, 3 cars, 2 cranes, 6 frames and towers, 12 ships and allied structures and 11 tanks.

Commenting on the list, Professor McKibben says that it "shows that this process is no longer in the experimental stage, but is a means of fabrication so extensively used as to warrant the attention of all structural engineers and architects." He continues:

"Welding has also been widely adopted in joining structural shapes and plates to produce substitutes for large castings—substitutes which are stronger, more reliable and more economical. If the accompanying list be any indication of the trend in structural engineering, one must conclude that the architect and engineer in their endeavor to keep pace with the development of improvements in the building arts must at least investigate the possibility of welding as a means of fabricating certain types of steel bridges and steel buildings. In many cases it will be found that welding is better and cheaper than any other form of construction.

"That responsible designers are taking this matter in hand," he concludes, "is some assurance that its use will be directed along safe channels."

TRAINING THE MEN WHO WILL KEEP NAVY AIRPLANES IN GOOD ORDER

One of the inducements held out by the United States Navy in a campaign for recruits is the fact that the Navy offers a great variety of opportunities to young men to learn a useful trade during the period of enlistment, which they may follow up later in life to good advantage. The training centers have such a fine reputation for the thoroughness of the instruction which they offer that the inducement is a real one. Such training, of course, differs from the ordinary trade schools, in that it involves full pay to the student during the period of instruction along with a splendid program of personal discipline and physical development which are thoroughly appreciated by the men who carry on through an enlistment in the right spirit.

One of the most attractive Naval Training Stations in the country is that situated at Great Lakes, Illinois, on the shore

Welding Class Recently Graduated from Aviation Mechanics School, Great Lakes, Ill.

of Lake Michigan, about forty miles north of Chicago. This station is under the command of Rear Admiral H. J. Ziegemeir. It has a splendid reputation for the thoroughness and success of its training methods and the good morale of the enlisted personnel. It is quite evident the aim of the officers is to get the highest possible rating for the work of the various training schools at Great Lakes.

The Aviation Mechanics' School at Great Lakes is now a greater attraction than ever before, offering, as it does, a thorough mechanical training in a branch of industry which within the past year has developed indication of an extremely rapid growth. It is, of course, essential that the Navy should provide itself with a good supply of aviation mechanics on its own account. There are a great many planes already in the Naval service and provision must be made to keep them in first class shape all the time.

The Aviation Mechanics' School is under the direction of Lieut. Commander R. W. Wuest; Lieut. M. C. Faber is the Instruction Officer; Lieut. F. W. Buzby is Personnel Officer; Chief Carpenter S. Butrick is Structural Officer and Test Pilot; Aviation Chief Metalsmith F. Teschner is Welding Instructor. The school has four courses of instruction: Advanced Machinists' Mates course of twenty-four weeks, the Aviation Metalsmith course of twenty-four weeks, the Aviation

Carpenter Mates' course of twenty-four weeks, and the Aviation General Utility course of ten weeks. Welding is one division of the Aviation Metalsmith course and the instruction in welding covers a period of six weeks. Special short courses in welding are given to advanced machinists' mates with the idea of making them thoroughly familiar with the principles of good welding without taking the time to work up any advanced skill in handling the torch.

On account of the vital necessity for sound welding in our work on airplanes the welding course is designed to give the students the most thorough training in the fundamentals of good welding in the time which they have to spend at school. Accordingly a great deal of care was exercised in planning the layout of the shop where practical work is done. In contains twelve individual welding stations, each equipped with a complete Torchweld welding outfit and with individual tanks of oxygen and acetylene. Enough space is provided so that each student has plenty of room to work without annoyance or interference by others or by people passing through the shop. At the close of each exercise each man is required to disassemble his outfit and pack it away in a steel locker, so that it has to be unpacked and entirely assembled at the beginning

Top to Bottom—1. Welding School at End of Period. 2. The School in Action. 3. View of Metalsmiths' Section. 4. Display Board Illustrating Range of Work Covered in Shop Training. The Welding Panel Is on the Right.

of the next exercise. For men who may be called upon to get into action at any time with a welding outfit with the least possible delay, this drill which produces complete familiarity with the equipment, is of great value. It is characteristic of the training given in the school that the instructors always have in mind the responsibility of the man being trained, and make it a point to prepare them to meet the emergencies which are an every day occurrence in service.

Ample time is provided for lecture and instruction periods, which clear up the students' understanding of the theory of welding. In this theoretical training each man learns just what the equipment is which he has to operate, what makes it operate, and how to keep it working at its highest efficiency. They learn the differences between different kinds of metal and how these differences influence the technique of operation in making a weld. The physical properties of the structure of a completed weld are thoroughly explained, so that in practice each man can determine for himself whether he is really doing good work.

A large display board carries samples of all of the shop exercises included in the complete welding course. These exercises are shown in various stages of development, so that the student can at any time check up on his own progress by comparison with a properly executed weld of the sort which he is making.

The regular course of instruction at this school is frequently supplemented by lectures given by men in the welding industry who visit the school for this purpose. The work is made so attractive for the men that a high spirit of interest is noticeable. Many of them supplement the regular instructions by reading the trade magazines and books on the subject of welding, and this reading suggests to them innumerable questions to bring up before their good natured instructor. Welding is an entirely new subject to most of them and almost uniformly they study it with interest, with the result that towards the completion of the course they show a very unusual degree of proficiency in handling the torch.

BRONZE WELDING FITTINGS TO TANKS

New uses are being found almost daily for bronze welding in production and reclamation work in all classes of industry. The bronze filler can be made to adhere to the metal and form a strong bond that will outlast the metal itself. The joint can be dressed down without impairing its great strength. Unheard of and unthought of economies in production costs and big savings in time, materials, labor and money in reclamation work are the result.

Bronze welding can be done below red heat and without preheating. This makes it possible to weld many broken parts in place without dismantling the job. Engineers and and welders know what tremendous savings can be accomplished when these clumsy, expensive operations are removed.

As an example of production possibilities, cast iron fittings can be successfully and securely bronze welded to steel units and without destroying the base structure of any of the three metals. Many engineers, however, will not specify cast iron fittings for steel units because they do not know they can be so successfully and firmly joined together. Nor are they familiar with the economies over old methods.

Steel fittings have to be carefully threaded so as to screw into specially prepared threaded openings in the unit. This adds materially to the cost. There is a tremendous loss of time. And the finished joint is not as sure.

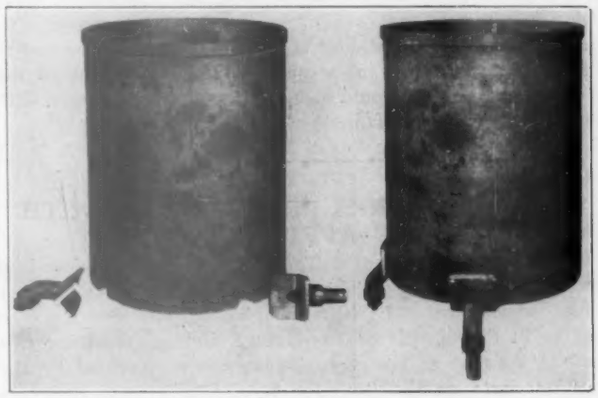
When specifying fittings of metal foreign to the unit, a common practice is to rivet or bolt the fittings on to the unit. This has not always been satisfactory either. Joints are not secure and there is a possibility of leakage.

The lower cost of cast iron fittings in comparison with steel fittings is apparent. The saving in time and labor in bronze welding them to the unit instead of threading, riveting or bolting, is almost beyond estimation. The resulting joint by bronze welding is always sure and stronger.

In the accompanying illustration the bronze welding of cast iron fittings to a steel storage tank, using the Lotan method developed by the Simplex Flux & Solder Co. of Cleveland, Ohio, is shown. The actual operation, and the tank before and after the fittings were welded into place are illustrated.

When finished, the bronze weld proved stronger than the iron and could not be broken. It was also possible to dress it down easily without in any way impairing its great strength.

Engineers of the Simplex Flux & Solder Co. of Cleveland,



Left: Cast Iron Fittings Before Welding to the Steel Storage Tank. Right: The Same Fittings Bronze Welded.

Ohio, have developed the Lotan combination—Lotan powder preparation and Lotan AB flux—for just such operations as this. Almost daily they are showing engineers new uses for bronze welding.

The Lotan powder preparation was sprinkled into the

Bronze Welding Cast Iron Fittings to a Steel Storage Tank.

chamfer to prepare the iron and steel by decarbonizing the surfaces and cleaning them thoroughly, so that the bronze filler would, and did, unite firmly. The Lotan AB flux prevented oxidation of the molten bronze and the metal surfaces and permitted a fill that was uniform in quality and free from blow holes. On the finished job a wire brush removed what little scale there was. An ordinary oxy-aceylene torch and a bronze filler rod was all the additional equipment needed.

EASTERN WELDING ORGANIZATIONS GROWING

Bulletins received from the eastern office of the United Welders of America indicate that membership in the eastern organizations is growing and that the men in charge of these organizations are attempting to do some real constructive work for their members. Their literature advocates that when a man has had sufficient experience to justify the title of welder mechanic his trade should be recognized. It is also one of their proposals to see that men welding on boilers, pipe lines, bridges, building construction, marine work, pressure vessel work and other important jobs should be tested and certified by competent authorities so that employers in charge of such work may be able to identify men who can be depended upon to carry it on without causing failure, which would produce poor impressions of the value of welding. They take issue with the statement that welding is so easy that anyone can do it and advocate that welding apparatus should not be put in the hands of workmen indiscriminately. In fact, that all use of welding apparatus should be under the direction of an intelligent supervisor who is familiar with the handling of it.

WELDING WORKS PROSPERS IN SOUTH AFRICA

In the May 25th issue of The South African Review is a sketch of the history of The "LC" Welding Works, 3, Bree street, Cape Town. The writer emphasizes the wide scope of welding in the life of the community, and in describing this plant states that nearly every industry is represented by the machine parts on the floor for repairs or alterations. Jobs are received from all parts of Cape Province, and in the six years since its establishment the shop has built up a reputation for dependable welding which has brought about a steady growth, necessitating two moves. The works are now housed in a spacious building, with room for further expansion.

Good working conditions have been provided, the most up-to-date equipment has been installed, and only skilled European mechanics are employed. The success of this shop's operations is increasing the acceptance of welding in Cape Province.

WRIGHT WELDING WORKS CHANGES HANDS

Announcement has been received that the Wright Welding Works, Miami, Oklahoma, was sold to Leander S. Larsh, who took over the business on June 27th, 1928. The Wright Welding Works has been operated at its present location on South Main Street, Miami, for the last ten years and for the two years before that Mr. Wright was engaged in the welding business at a nearby town. Mr. Wright is known not only as one of the old timers among the business men but also as a substantial citizen of the town, having taken part for many years in civic affairs. The shop is located on Highway 66 and is known to tourists from one end of the country to the other for its excellent work. Mr. Wright has kept in close contact with the development of welding during all this time, the circulation records of *The Welding Engineer* showing that he has been a subscriber ever since the publication of the first issue in January, 1916.

ROACH JOINS MUELLER SALES STAFF

Mr. W. Roach, formerly of Buffalo, N. Y., is now associated with the Mueller Brass Co. of Port Huron as Assistant Sales Manager of the Mill Products Division.

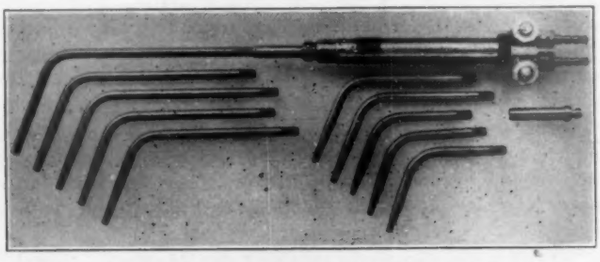
For the past ten years Mr. Roach has been with the American Brass Co., the last four of which he has been manager of the Sales Promotion Department of the Buffalo Branch. He has had many years experience in the plumbing, building and architectural fields and is thoroughly conversant with this trade in New York, Pennsylvania and Ohio.

Previous to his ten years' connection with the American Brass Co., Mr. Roach was connected with Dodge Brothers in the manufacturing departments.

AIR REDUCTION SALES COMPANY ANNOUNCES NEW TORCH

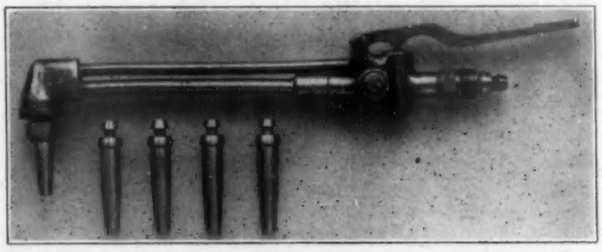
The Air Reduction Sales Company, 342 Madison avenue, New York, is placing on the market through its district sales offices a new general purpose Airco-Davis-Bournonville welding torch, known as Style 8800, designed for light, medium, and heavy welding, covering the range from $\frac{1}{16}$-inch metal up to the heaviest sections.

The new torch, tested and approved by the Underwriters Laboratories, has the standard hose connections, endorsed by the International Acetylene Association, American Welding Society and others; also compact, quick-opening and closing



Airco-Davis-Bournonville Style 8800 Welding Torch with Ten Tips and Two Mixing Heads.

needle valves, and one-piece tapered copper welding tips. The tips, tapered from one piece of seamless copper tubing and bent to the welding angle of 67½ degrees, afford maximum heat resistance in difficult, confined space welding. Oxygen and acetylene, conveyed in separate seamless tubes through the handle, combine in a mixer head fixed to the front end by



Cutting Attachment with Five Cutting Tips for Style 8800 Welding Torch.

an annular nut; the tips, screwed into the mixer head, make up against flat seats, well away from the welding heat. The oxygen and acetylene tubes in the handle are silver soldered to the front and rear ends.

Two mixer heads cover the range of ten welding tips—No. 1 mixer for tips Nos. 1-7, and No. 2 mixer for tips Nos. 6-10, inclusive. The theoretical oxy-acetylene ratio of one volume of oxygen to one volume of acetylene through the tip is very nearly realized in this torch, the actual ratio being approximately 1.01 oxygen to 1 acetylene.

The new torch is a general purpose, all-around welding tool for production and repair work in factories, industrial plants, railway repair shops, mills, shipyards, welding shops, garages, and pipe fitting shops. It is peculiarly adapted to pipe welding in the field or to pipe installations in buildings. To make it complete for fabrication and welding a cutting attachment, shown in the accompanying photograph Fig. 2, has been designed to fit the head connection in place of the mixing head

and welding tip. Thus, the user can quickly convert it into an efficient cutting torch, without uncoupling the hose, by simply replacing the tip and mixer unit with the cutting attachment. The torch then cuts and bevels pipe and all thicknesses of steel up to 6 inches; it is made with either 75-degree or 90-degree angle heads. The cutting oxygen jet is controlled by the thumb lever at the rear.

The weight of the new torch with No. 5 tip is 29 ounces, and length over all, 17 inches. The complete assembly of torch with any welding tip and mixer, or with the cutting attachment, is light, well-balanced and can be used for long periods without undue fatigue. Hose connections are for ⅜-inch inside diameter oxy-acetylene hose.

WELDING HAND BOOK PUBLISHED BY STOODY COMPANY

A different kind of welding handbook, new in idea and make-up, has just recently been published by the Stoody Company of Whittier, California, manufacturers of welding rods, welding alloys and welding equipment.

The makeup of this new handbook is along the lines of a scientific treatise on the art of welding—both the acetylene and arc methods being presented for study. The extent of the treatise is closely related to the drilling divisions of the oil industry, for the treatment of hard facings, the reclamation and reconstruction of drilling tools and equipment, and the general uses of welding on and about the drilling rigs is stressed above other forms.

Structural makeup of this new handbook makes it applicable to anyone caring to use it, for the articles are illustrated by photographs, charts and diagrams, these showing the finished products, the metallic strength, etc., of the rods being used. From the cover sheet to the closing page the book is most interesting, there being little "padding" in it. It was published with the idea of giving a thorough outlook on the most modern methods without becoming uninteresting.

The section of the book dealing with the hard facing of bits will especially appeal to the operators, since this method of dressing bits is used by most all operators of the present, in order that their bits may make more hole on a faster basis. As interesting as the preceding section is that one dealing with the reclamation of tools and equipment. This division is installed for the purpose of showing operators how many times the purchase price of an article can be saved by welding it.

One hundred pages constitute the length of the book. These one hundred pages are one numerous list of facts that appeal to both the acetylene and arc welders. With this idea in mind the Stoody Company have announced that all those caring to receive this book may obtain it by addressing the company at Whittier, California.

NEW K-G REGULATOR

The K-G Welding & Cutting Co., 515 West 29th street, New York City, manufacturers of oxy-acetylene welding and cutting apparatus, have just announced the production of a new line of oxygen and acetylene pressure regulators. Considering the pressure regulator to be of prime importance in the proper functioning of the welding or cutting torch, it has been their aim to bring about the maintenance of uniform pressure on the working gauge of the regulator irrespective of the decreasing pressure in the cylinders. In the new regulator they claim to have overcome the most common difficulties in the operation of pressure regulators, that is, the fluctuation in the pressure delivered to the torch and freezing.

The manufacturers point out that the new K-G regulator is a departure in construction of such devices in that it is constructed on the principle of the pressure in the cylinders closing the valve. This principle enables the outlet from the high pressure side of the regulator to the low pressure side to be of ample size to allow a large volume of gas at low pressure to be supplied to the torch, which in itself is indicated as a decided advantage.

The principal feature of this new type of regulator construction which overcomes the fluctuation of the pressure is a swivel or universal joint between the diaphragm and the valve stem. This type of construction was suggested because the designers noticed that due to uneven compression of the springs, the valve stem, if rigid at the diaphragm, is forced out of alignment when the mechanism is in operation. Consequently, when the regulator is functioning and the springs

The K-G Regulator and Gauges.

are under compression, there is quite some extra pressure required to be applied at the diaphragm to seat the valve stem, and this condition causes pressure fluctuation and creeping. The swivel joint allows the valve stem to be brought into alignment for making its proper seat without extra pressure and thus maintains the uniform pressure in the working gauge. The swivel joint allows the use of a metal diaphragm, but the K-G regulators are supplied with two-ply rubber unless especially ordered.

Further advantage claimed for this type of construction is that a considerable number of additional feet of gas can be drawn from the cylinders. Exhaustive tests have been made to show the resistance to freezing with the thermometer reading as low as 15 degrees and using a tip with a No. 20 outlet, there was no sign of a stoppage in the flow of oxygen.

Each regulator is equipped with an up-to-date safety blow-off which will operate should not an excess of pressure get into the outlet or working chamber. The regulator is equipped with cylinder connection, high pressure gauge showing the contents of the cylinder, low pressure gauge and a hose connection nipple. Needle and check valves instead of hose connection nipple can be supplied if wanted. The case of the high pressure or oxygen gauge is cast with a solid front in a blow-out back which eliminates any danger of the crease being brought to the front and causing damage.

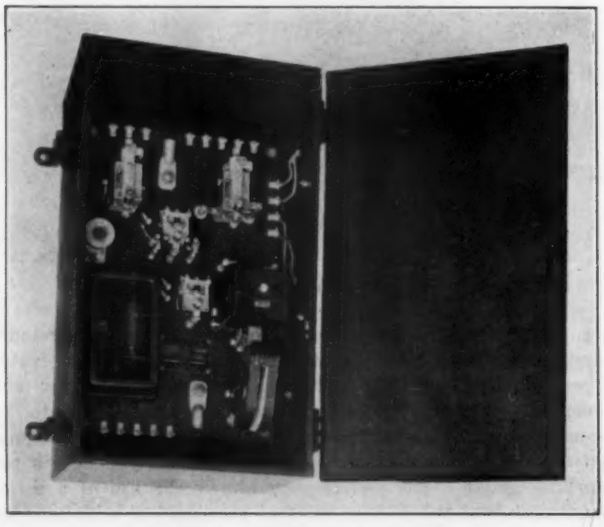
Previous to making arrangements for the production of this new line of regulators for the market, all models were subjected to careful laboratory tests as a check on the working qualities on the new type of construction, and a number of them were placed in service in large industrial plants where the work was of such nature as to give good indication of their working qualities under severe requirements.

NEW CONTROL FOR AUTOMATIC ARC WELDING ELIMINATES ARC CRATER

The General Electric Company announces an improvement in the control equipment used with its automatic arc welding heads, by means of which the feed of electrode wire is stopped a short time before shutting off the welding current at the end of the weld. This serves two purposes: first it clears the electrode from the weld and, second, it fills in the crater which is inevitably left at the end of the weld when the arc is cut off short.

According to the manufacturer, it is always desirable to have the electrode clear of the weld when removing the work from the clamping fixture, to prevent the end of the wire from dragging. This is of particular importance with large sizes of wire. Many users of arc welding also want to eliminate the undesirable crater, as they find its presence is objectionable especially on circular welds of small diameters where one end of the weld is lapped over on the other end.

The General Electric control panel for its automatic arc welding heads is controlled by a "START-STOP" push-button station. Mounted on the panel are a line contactor of suitable size for the welding current, an arc voltage regulating relay, and relays for controlling the travel motor and for clearing the electrode from the weld. The rheostats for controlling the arc voltage and the speed of the electrode motor



Automatic Welding Head Control Panel

are mounted on the outside of the sheet metal enclosing case. A small meter panel is used for indicating the arc voltage and welding current.

In operation, when the end of the weld is reached, the operator pushes the "STOP" button which opens the auxiliary contactor. This in turn stops the electrode motor and opens the magnetic clutch circuit, thus stopping the wire feed. The line contactor remains closed for a short time because of the action of a time-delay relay. This allows the arc to burn back the electrode sufficiently to clear the weld and also to fill in the crater. The time-delay relay then opens and in turn opens the line contactor, and stops the travel motor by opening the travel relay.

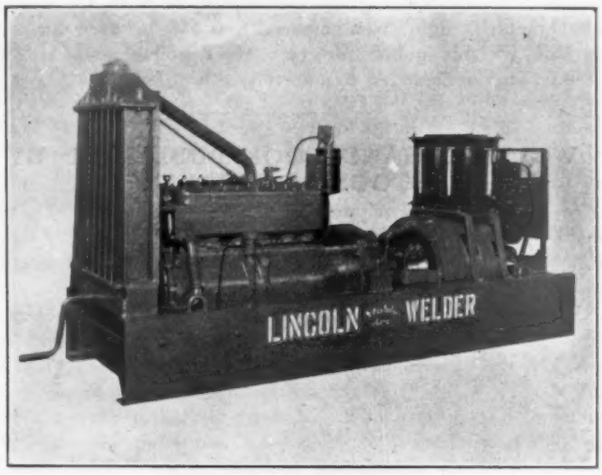
LINCOLN 75 TO 400 AMPERE WELDER

The Lincoln Electric Company, Cleveland, Ohio, announces a new 30 ampere gasoline engine driven welder, known as Model S-1964. The welding generator is rated at 300 amperes in accordance with N.E.M.A. Standards and has a current range of from 75 to 400 amperes for metallic electrode welding, and is direct connected to a six-cylinder Buda Model HS-6 engine, operating at 1500 R. P. M.

Both units are mounted on a welded steel base, thus giving maximum strength and rigidity with minimum weight.

The engine has an S. A. E. rating of 27.3 HP and gives a brake horsepower of 41 while running at the operating speed. It is said to be very economical in gasoline consumption. The gas tank is located in the channel iron frame under the engine, thus eliminating fire hazard.

The generator has the laminated magnetic circuit with separately excited field, stabilizer, variable voltage and steel construc-



Lincoln Model S-1964 Welder

tion features characteristic of the company's line of "Stable Arc" welders.

The over all dimensions are 93 inches long, 35 inches wide with an over all height of 45 inches.

The equipment has been designed to meet the constantly increasing use of larger electrode in welding, and the six cylinder performance gives a smooth, even flow of power so necessary for succesful welding.

IMPROVED CAUSTIC POTASH CONTAINER

The physical structure of caustic potash renders it very brittle; thus, the ordinary grades, produced mostly in Germany, and

A Strong Moisture-Proof Container for Caustic Potash

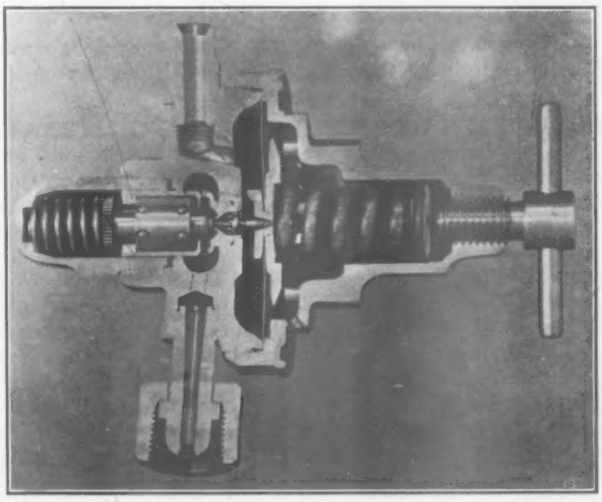
shipped overseas to an American port, arrive chipped. It is stated that as a result of this chipping some times as much as 5 per cent of the total drum contents arrives in a fine granular state, and if put in the drying cylinders, packs down tightly, preventing the free passage of gas and becoming so jammed as to make it necessary to reload the cylinder. In addition, the

drums are often dented or broken in their overseas journey, frequently arriving with "hook-holes" in them, allowing the air to get at the contents of the drum and impairing its efficiency.

Innis, Speiden & Company of New York City, have been active in the development of caustic potash in all its phases, and are now producing it in solid, walnut, flake, granular and liquid forms for various uses. The requirements of the oxygen gas industry have been thoroughly studied from both scientific and economic angles, and the company's engineers spent several years in research work, not only in the laboratory but in the plants of gas manufacturers, before the placing of Isco American Selected Walnut Caustic Potash on the market. The product is produced in sufficiently large quantities to permit of its continuous manufacture, which means each shipment has been manufactured immediately before forwarding. This insures freedom from carbonization, moisture and fine particles, and drums are in perfect condition upon arrival. The drums themselves are of superior quality, being of heavier steel and painted to prevent rust. They possess large friction cap, readily removed and replaced, permitting the preserving of contents in original form. Some consumers find that these drums have a re-sale value, thereby lessening the net cost of the product.

THE VICTOR SAFETY REGULATOR

The Victor Oxy-Acetylene Equipment Company, San Francisco, Calif., announced some time ago that after two years of shop and laboratory experience, they designed and are now making what is called the Victor Safety Regulator. In the basic design of this regulator, particular stress was laid on the elimination of hazards and the creation of a pressure regulating device which would assure pressure accuracy and sensitiveness. The manufacturers state that this new regulator is not a delicate piece of mechanism, but an exceedingly sturdy one.



The Victor Safety Regulator

Both regulator body and regulator spring housing are Tobin bronze die forgings. The regulator tension screw carries a stainless steel ball bearing point resting upon a spring button. Double roller bearings, with stainless steel balls, assure positive alignment of the seat and seat holder and facilitate unrestricted up and down, as well as circular motion of the seat. Seat plunger is manufactured of Everdur which will resist corrosion and friction of stainless steel ball bearings. The seat itself is reversible and can be removed readily without special tools other than the wrench fitting the tank connection nut. The regulator is screw assembled throughout (no solder is used in this connection).

Instead of passing the inrushing gases through the regulator nozzle directly against the seat, the paths of the gases are changed to eliminate the dangers of spontaneous combustion of the oxygen regulator seat, as well as freezing. The gases enter the tank connection tail piece and thence pass through two "V" shaped openings, in opposing directions, into a circular chamber. Here gas meets gas and impact friction at the seat is eliminated. From the larger circular chamber the gas now passes into a smaller circular chamber, crosses the seat, entering the nozzle and through the drill holes of the balance pin (stainless steel), against the balance pin centralizer into the low pressure diaphragm chamber.

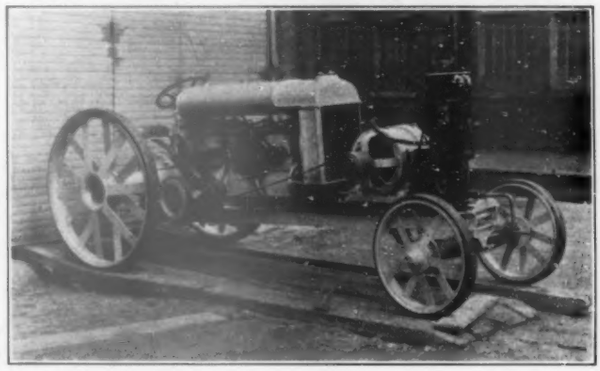
The diaphragm for oxygen, acetylene and hydrogen regulators is straight and not dished. Its up and down motion is restricted and the large rubber gasket located above the German silver diaphragm gives added protection against buckling or shearing. The regulator is provided with a safety valve bursting disc arrangement. The balance pin is flared out at the point where it rests upon the loose seat and practically closes the nozzle opening and thereby gives added protection to that seat. The seat is removed from the nozzle by the pressure upon the diaphragm and the balance pin and this motion also opens nozzle automatically. The entire construction is of such sturdiness and design of such simplicity that there is nothing to get out of order and nothing will need replacement other than the regulator seat. This regulator seat change can be facilitated within 60 seconds.

The outstanding features of the Victor Safety Regulator is primarily its safety and its great pressure accuracy and sensitiveness. Production facilities are such that the Victor Company is now in a position to make prompt shipments to all localities.

NEW MOUNTING FOR ARC WELDERS

A new mounting of the Standard Lincoln Electric Stable Arc Welders, has been announced by the sales department, of the Pontiac Tractor Company, Pontiac, Michigan.

The Welder Unit with stabilizer and panel are mounted on a frame, which attaches to either the McCormick-Deering 10/20 or Fordson Tractors.



Pontiac Self-Propelled Welding Unit

This mounting of the Pontiac Lincoln Arc Welder, gives a four wheel rubber tired Self-Propelled unit, capable of hauling heavy loads behind itself. This unit is also mounted on crawlers for soft ground work.

Power is taken from the tractor, to drive the welder, through the power takeoff pulley, which has a clutch, allowing it to be thrown out or into gear at will. The ahead drive of the belt, brings the belt tightener into the correct relation with the belt.

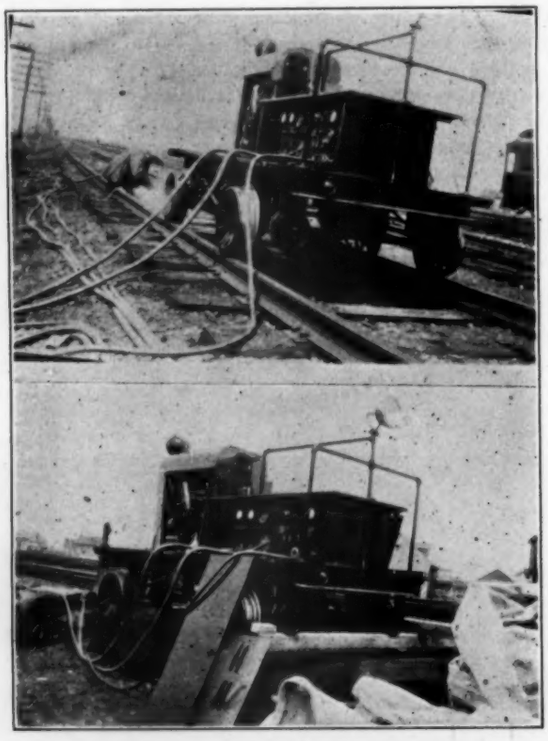
The manufacture states that a number of these units have been put out as special equipment, over a period of four years, and have proven very successful, on pipe line construction and structural steel fabricating showing considerable saving, over former methods of welding.

SELF-PROPELLED COMBINATION WELDING AND GRINDING CAR FOR TRACK WORK

A self-propelled electric welding machine—designed especially for both arc welding and grinding work on railway tracks—has recently been developed by the Wilson Welder & Metals Company, Inc., of Hoboken, N. J. A standard Wilson Model "S" Welding Generator, driven by a Continental gasoline engine

through flexible coupling, supplies all the power required for driving the car, welding and lighting. Directly connected to the welding generator by flexible coupling is a 3.5 kw., 110 volt grinding generator which operates any make of grinder. This Wilson machine provides a welding range of 10 to 300 amperes at 25 volts. Welding up to 200 amperes and grinding can be carried on simultaneously.

The complete welding and grinding outfit, with motor, is mounted on a welded steel car, with pressed-steel, roller-bearing wheels. Brake shoes operate on all four wheels. A special device for derailing is provided, consisting of four small wheels—mounted behind the larger wheels, and clear of the tracks—which fit on derailing trackage, and permit the car to be rolled quickly and easily to one side.



Wilson Track Welder and Grinder. Above; on Track. Below; Derailed.

A standard electric automobile motor chain geared to the rear axle, supplies the motive power. The motor is controlled by a "dead hand" handle, conveniently located, which operates forward and reverse. Speed is controlled by varying the voltage of the generator. A knife-switch, conveniently placed on the panel, operates in two positions—"weld" and "run"—and shuts off the welding current when it is desired to run the car.

As the car is equipped with head and tail lights, and also facilities for operating a flood light, efficient work can be done at night. It is also supplied with a large toolbox. Removable top and sides are furnished to protect the generators and panels from the weather. The gasoline engine is enclosed in a metal hood with removable sides. All operating parts are readily accessible. The car seats four men comfortably. Total weight, 3,000 lbs.

This machine, carrying four men, made 19½ miles an hour on level tangent track. When a trailer weighing 700 lbs., was carried, two extra men and a lot of cable, was hitched onto the machine, with all this load it made 13 miles an hour on ½ per cent grade.

G. E. BULLETIN FEATURES TRAVEL CARRIAGE

Bulletin G. E. A-994, recently prepared by the General Electric Company, illustrates and describes a travel carriage for automatic arc welders. This carriage carries a single welding head for light and medium welding, but for heavy duty welding it is supplied with a double welding head. The carriage is designed for use with welding longitudinal or straight seams. The illustrations in the bulletin mentioned show various types of set-ups which can be used.

I. O. C. PRODUCES NEW VALVE

The International Oxygen Company, Newark, N. J., has just announced a new model I. O. C. high pressure packingless valve which has several new features. Style No. 9099 is made for oxygen, hydrogen, nitrogen, helium and compressed air. Style No. 9090 is made for acetylene only. The valve bodies are of drop forged brass. The set screw is case hardened mild steel threaded 18 threads to the inch. The rolled brass bonnet is designed to provide maximum clamping effect on diaphragms. A reinforcing ring prevents expansion and eliminates the possibility of leakage between the bonnet and the diaphragm. The safety device is frangible disk to break at 2,600 to 2,800 pounds pressure, supported by fusible metal to melt at 212° F. This construction is approved by the Bureau of Explosives of the Interstate Commerce Commission and the valve itself is approved by the Underwriters' Laboratories.

LINCOLN BOOKLET COMPARES ARC WELDING MACHINES

Two entirely different types of equipment for arc welding are compared in Engineering Bulletin No. 206, recently issued by the Lincoln Electric Company, Cleveland, Ohio. These are the Variable-Voltage, Single-Operator type and the Constant Potential, Multiple-Operator type.

The discussion covers:

1. The first cost of the equipment plus installation cost.
2. The problem of interference between operators on multiple operator sets.
3. Economy of power of variable voltage equipment, curves being included to show graphically this power economy.

ACTIVITIES OF THE INSTITUTE OF METALS

The Liverpool meeting of the Institute of Metals, to be held on September 4-7, is proving very attractive. Already over 200 members, including many from overseas, have indicated their intention of taking part in the meeting. The papers to be presented include a valuable series dealing with the die-casting of alloys, as well as the Eighth Report of the Corrosion Research Committee. A "full-dress" discussion of corrosion problems will form a feature of the meeting. It is particularly appropriate that this discussion should take place in a maritime center such as Liverpool. On the social side the gathering promises to be a pleasant one; a series of receptions, visits to places of interest and other functions is being arranged by the local reception committee. On July 4 an election of members is taking place in connection with the Liverpool meetings, full particulars of which can be obtained from Mr. G. Shaw Scott, M. Sc., Secretary, Institute of Metals, 14 Members' Mansions, Westminster, London, S. W. 1.

INTERNATIONAL ACETYLENE ASSOCIATION WILL MEET IN CHICAGO NEXT NOVEMBER

At a meeting of the Board of Directors of the International Acetylene Association held June 8th, it was decided to hold the annual convention in Chicago on November 14, 15 and 16. A special Program Committee for the convention was appointed on the same day and is now making preparations to secure a good collection of technical papers dealing with important phases of the use of acetylene in industry. The annual meeting of this Association is well known as a source of valuable contributions to the literature of welding. More complete details regarding the coming convention will be published in following issues.

Repair-Welding Intricate Castings with TOBIN BRONZE

Reg. U. S. Pat. Off.

The two upper illustrations show the pieces of a broken cast-iron machine part. The lower illustration shows the part repaired with Tobin Bronze—as good as new.

IT is frequently difficult to replace intricate castings without delays that perhaps seriously interfere with production. Even new patterns are sometimes required before the new casting can be made.

But why order a new part when the broken one can usually be made serviceable by oxy-acetylene welding with Tobin Bronze.?

Tobin Bronze Welding offers many advantages for repairing broken castings, or building up worn surfaces. It is not necessary to melt the edges to be joined as Tobin Bronze flows freely at 1650°F., producing a sound homogeneous weld stronger than the casting itself.

In repairing the part illustrated, any danger of warping was avoided as preheating was not necessary .... frequently this advantage of Tobin Bronze Welding saves the time of dismantling and reassembling.

Many industrial plants which have proven the value of Tobin Bronze Welding in repair work are now using it to save time and money in manufacturing operations. Tobin Bronze Welding Rods may be obtained from leading distributors of welding equipment and supplies.

THE AMERICAN BRASS COMPANY
GENERAL OFFICES: WATERBURY, CONN.
Offices and Agencies in Principal Cities
In Canada: ANACONDA AMERICAN BRASS, LTD.
New Toronto, Ont.

ANACONDA WELDING RODS

To be sure of obtaining genuine Tobin Bronze, look for the trademark in every rod .... Tobin Bronze is exclusively an Anaconda Product.

ANACONDA
from mine to consumer

There is a suitable Anaconda Filler Rod for every welding purpose. The principal Anaconda Welding Rods, with their melting points, are listed below:

for oxy-acetylene welding

Tobin Bronze	1625°F
Manganese Bronze	1598°F
Brazing Metal	1634°F
Deoxidized Copper	1981°F
Electrolytic Copper	1981°F
A. B. Naval	1625°F
Everdur	1866°F
Ambrac	2102°F

for arc welding

Phosphor Bronze	1922°F
Everdur	1866°F
Ambrac	2102°F
Deoxidized Copper	1981°F

This Year National Metal Week

AND

National Metal Exposition

will be held in Philadelphia at the Commercial Museum October 8 to 12 inclusive. ¶ Make a memo of the date. Write your favorite Philadelphia hotel for reservations. Start telling your friends now that you're going to be there. ¶ It's going to be this year's most important event in the metal manufacturing, using and working industries. ¶ Don't miss it. ¶ The American Society for Steel Treating, 7016 Euclid Avenue, Cleveland, Ohio.

Why Do the "Regulars" Come Back Year after Year?

We can count right now on one fact—that a large number of those in attendance at the tenth *National Metal Week* and National Metal Exposition will be from the same group of companies which have been represented every year since the A. S. S. T. first sponsored this recognized annual event.

Why do they come back?

Because they *know from experience that it pays and pays big.*

Some companies started by sending one man. Now they send a dozen, ranging from the president, or vice-president in charge of production, down to the foremen. They know that industrial growth today is just as much a matter of man-power—brain-power—as it is of capital or policy, and that brains need stimulation.

Send your key men to Philadelphia this year for inspiration, stimulation and education.

You won't regret the investment.

Tenth Annual Convention & Exposition
PHILADELPHIA
Commercial Museum
Week of October 8th
1928

"STANDARD"
Welding Wire
GAS AND ELECTRIC
A grade for each type of work—send for samples.

for sound permanent welds : : lower costs
Our costs are considerably under those of large industrial centers; ours is a one-profit wire sold direct to user from our own mills exclusively devoted to making of welding wire from raw material to finished product—hence our extremely low prices for wire that is definitely superior. Adopted exclusively by many large users.
Prices on request.
Standard Steel & Wire Co., Greensburg, Pa. (Mills at Bolivar, Pa.)

News of the Welding Trade

The Annual Convention of The American Railway Tool Foreman's Association will be held at the Hotel Sherman, Chicago, on September 12th, 13th, and 14th.

At the May meeting of The Victorian Institute of Welding Engineers, held at Melbourne, Mr. D. J. Hay delivered an interesting lecture on "Welding Economies as Practised in the Victorian Railways."

The Westinghouse Electric & Manufacturing Company announces that J. K. B. Hare, recently manager of the Columbus, Ohio, office, has been appointed assistant central-station sales manager of that company. He will have his headquarters at the company's office at 150 Broadway, New York City. Mr. Hare has been with the Westinghouse interests for the last sixteen years and was connected with the company's Pittsburgh office prior to assuming management at Columbus.

The Naylor Spiral Pipe Company announces a change in its name to the Naylor Pipe Company and also an increase in plant facilities of some 200 per cent. The new facilities make possible the manufacture of a new product under the trade name of Spiralweld Toncan Iron Pipe.

Akron Welding Co., Akron, O., has bought a site on which an addition will be built. It is planned to add an auto spring division to the present welding business.

The Virginia Gas Products Corporation, Newport News, Va., has just completed the installation of an oxygen plant, having a capacity of two million cubic feet a month. This installation was made by the Keith Dunham Company, Chicago.

Mr. Chas. Haines, Vice-President in charge of Engineering of the Keith Dunham Company, Chicago, sailed on the Aquitania, June 21st, for an extensive engineering trip in Europe.

Gibb Welding Machines Company of Bay City, Michigan, manufacturers of arc, spot, steam and butt welders, has increased capital stock by $125,000.00, making a total of $250,000.00.

Prest-O-Lite Co., 30 East Forty-second Street, New York, manufacturer of acetylene gas apparatus, etc., has acquired property at Louisville, and plans early construction of branch plant, to cost about $40,000. Linde Air Products Co., Inc., an affiliated organization, has acquired adjoining site and is said to be arranging for immediate branch plant here, to cost close to like amount.

Classified Ads

Help Wanted—75c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Counted 8 words to line. Add 6 words for keyed address.

Wanted—Used Lincoln arc welders. Give history and full details in your reply. Address Box No. 152, care The Welding Engineer.

Lewis Seam-Welding Head
PATENTS PENDING
Fits Any Spot-Welder
Proven by 3 Yrs. Use

Will weld *side seams* or *bottoms* of buckets, pails or tanks at 15 to 25 ft. per minute and make joint water and gas tight.
Change from "Spot-Welder" to "Seam-Welder", or the reverse, made in 5 minutes.
One user has made over 1½ million 3 inch lap joints and then nickel plated the piece. **You can't find the joint.** No change to your spot welder — simply clamp Head to upper horn. Bolt on the proper electrode for either transverse or longitudinal welding. The "drive" is a separate unit and NOT attached to spot welder.
Send at once for Bulletin 129.
WELDING APPLIANCE CO.
2111 West Lake St., CHICAGO

Electric Welders—All types, new, used. W. Montelius Price Co., Seattle, Wash.

Wanted—Experienced salesman to act as representative for mill manufacturing welding wire exclusively. Address Box 154, care of The Welding Engineer.

Will Sell or Lease on easy terms complete small plant for manufacturing office furniture, radio stands, collapsible chicken crates, etc., in which tubular steel or wire, welded is the predominating material. Red Wing Printing Company, Red Wing, Minnesota.

For Sale—Complete outfit G. E. W. D. No. 12 arc welder. Single operator, constant energy, self-excited, 75 to 300 amperes. Direct-connected Hercules Model-O power unit, standard. Mounted on cheap truck. In good working order, ready to go to work. Address Box 155, care of The Welding Engineer.

Instructor Wanted—Qualified to teach oxy-acetylene and electric welding in new public vocational school at Niagara Falls, N. Y. Excellent opportunity. Address The Welding Engineer.

Wanted—Position as boiler shop foreman. 20 years' experience as layerout. Have welding experience. First class reference. Address R. E. Edwards, 2506 Lister Avenue, Kansas City, Missouri.

Position Wanted—Welding engineer with 12 years' practical experience. Thorough knowledge of manufacture and sales of fuel gases and welding apparatus, gas and electric. Graduate mechanical and metallurgical engineer. Address Welding Engineer, care Myers, 216 Willis Ave., Bronx, N. Y. City.

---for Strong welds

Nichrome

TRADE MARK REG. U. S. PAT. OFF

---the exceptionally strong Welding Rod

Welds made with "Nichrome" the nickel-chromium alloy, possess exceptional strength. For example, practical tests of welds on mild steel made with "Nichrome" rods, show an ultimate tensile strength as high as 55,000 pounds per square inch. It is interesting to note that the welding operation does not detract from the metal itself.

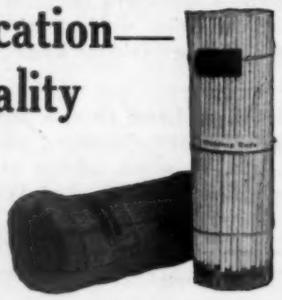
"Nichrome" welds are readily machinable and may be applied by either the oxy-acetylene or arc welding process. The ease of application and free flowing qualities of "Nichrome" welding rod, together with the fact that it can find wide application, makes its use extremely desirable.

Sample? If you are having difficulty in getting a strong weld, we are sure "Nichrome" will prove satisfactory. *Sample rods will be sent on request.*

DRIVER-HARRIS COMPANY
HARRISON, NEW JERSEY
Chicago - Detroit - Morristown, N.J. - England - France

Alloy Makers since 1899

Our Specification— Welding Quality



WHATEVER your specifications for welding wire may be, we specify that our wires must always have high welding quality. In the Seneca line you have a wide range of choice as to composition, finish, etc., with the assurance that each type will do the kind of welding you want.

Whether you use oxy-acetylene or metallic arc, there is a "Seneca Gas Weld" or a "Seneca Electro Weld" that will produce the desired quality of weld. Either can be obtained as Special Soft, Medium Hard, or Extra Hard, in coils or straight lengths, in black, bright, copper finish or flux coated.

Let us know the requirements of your welding job, and the materials to be welded, and we will be glad to advise you in the selection of exactly the right rod from the wide variety produced by Seneca.

The Seneca Wire Mfg. Co.
Established 1905
Fostoria Ohio
AGENTS WANTED—COMMISSION BASIS

Don't Use Costly Gas and Time Getting a Neutral Flame

The WELDIT GASAVER

Saves That Useless Cost

ONE flame adjustment lasts all day. Torch is hung on hook when not in use, and no gas is burned. A pass of the torch tip over the pilot light gives you the neutral flame you had before. Savings as high as 40% have been reported. It's a safety device, too. An automatic check valve keeps flash-backs from reaching hose or regulators. The Gasaver can be used with any type of apparatus.

Approved by National Board of Underwriters
Licensed Under Basic Patents

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Welding Torches	Cast Iron Rods
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Regulators	Brazing Wire
Lead Burning Equipment	Fluxes & Solders
Welding Wire	Safety Gloves
Welding Goggles	Service

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Willson Helmet No. 130

MODERN welding demands protection that keeps pace with the many new uses and forms of welding.

Willson Welding Helmet No. 130 is right up-to-date on all requirements. Eye health, sight protection, breathing comfort, head contact, durability, sweat elimination, handling ease,—these and other vital points make "130" Helmet specified by many practical welders. Price $10.20 each—of course with Willson-Weld Glass.

WILLSON GOGGLES, INC., READING, PA.

Manufacturers of safety goggles, respirators, welding helmets and handshields

LEGAL NOTICE:—Our Helmets and Handshields are protected by patents and notice is given of prosecution of infringers.

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GAS ENGINE DRIVEN

So different in its design and operation that it merits investigation.

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Welding Equipment and Supply Division of Chicago Steel & Wire Company

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K-G

THE "K-G" Regulator, manufactured by the K-G Welding & Cutting Co., Inc., New York City, is bound to be as popular as the "K-G" torches, because they are solidly and properly designed and built.

They also embody new and original ideas and improvements in the interior mechanism which will eliminate the many defects and faults that are experienced today with other regulators.

The seat closes with the tank pressure and the bodies are of forged brass. A trial and demonstration will convince anyone that they are the best yet brought out.

With complete "K-G" manufactured Welding and Cutting Equipment you have the very best money can buy.

K-G WELDING & CUTTING CO., INC.

515 West 29th Street **New York City**

slight the *rod* and spoil ... the *weld*

WHEN you simply specify "welding rods," you cannot hope to get satisfactory performance.

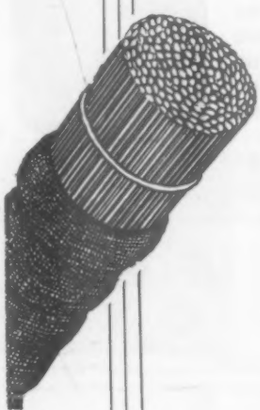
If you specify WISSCO Welding Rods you insure against loss and disappointment.

They are carefully graded to meet specific requirements and are pre-tested to insure quality results.

If you have a welding problem our Engineers and Metallurgists will aid you in its solution.

Their experience is the broadest; their services cost you nothing.

Call upon them on any welding question.



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WICKWIRE SPENCER STEEL CO.

WISSCO WELDING RODS

In 55 minutes, five breaks in this electric motor bearing housing were bronze welded by the Lotan Method, without preheating. Ordinary welding methods would have taken four hours. Entire piece easily machined—no loss in strength.

Now! No Job too difficult for any welder using LOTAN

How many welding jobs have you turned down this year because you thought they were too difficult, could not be done, or were too costly.

Figure your costs—gas, time, labor and materials—on any welding job. Take the most difficult and the most costly you have done. Divide the costs by two and you'll know what the LOTAN METHOD of bronze welding cast iron would save you.

Bronze welding of cast iron can now be done below red heat and without pre-heating. Most broken parts can be bronze welded in place or without dismantling. The finished joint can be machined as safely as the original metal.

Big jobs; heavy jobs; jobs in awkward positions: jobs of unusual design; jobs of odd shapes; jobs in place; can all be done quickly, easily, economically with the LOTAN COMBINATION.

For all users of oxy-acetylene welding equipment—factory, foundry or shop—the Lotan Combination—Lotan Powder and Lotan AB Flux—means lower welding costs, less waste, greater efficiency.

Lotan Powder prepares the iron so that the bronze filler unites securely a joint stronger than the iron, whether one, two or three metals are being joined.

Lotan AB Flux prevents oxidation of the molten bronze; the fill is more uniform in quality and free from blow holes. A wire brush will remove the slight scale on the finished job.

A pinch of Lotan Powder, a bronze welding rod dipped in Lotan AB Flux and an oxy-acetylene torch is all the equipment needed.

Stop turning down welding jobs. Give the Lotan Combination a trial—today. Sent postpaid for $4.00 to any part of the U. S. A. ORDER. TODAY.

Write, today, for our distributor proposition. A few choice territories still open.

Simplex Flux & Solder Co. of America

1978 E. 66th St. Cleveland, O.

We also manufacture fluxes for welding brass, copper, steel, bronze, aluminum and other metals. Descriptive folders upon request.

American Steel & Wire Company's

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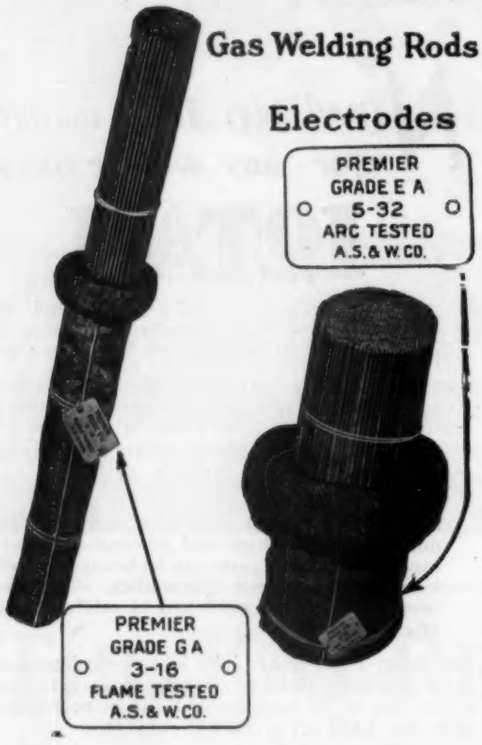
WELDING WIRES



Gas Welding Rods

Electrodes

PREMIER Welding Wire flows freely, giving perfect fusion, thorough penetration and the desired finish. The uniform quality of Premier Welding Wire insures a deposit of metal in the weld free from foreign inclusions and possessing maximum strength. Before shipment, every bundle is electrically tested and manually welded. Permanently satisfactory welds and a saving of gas, electricity and the welder's time are thereby assured.

For a dependable welding job, use an appropriate grade of Premier Welding Wire. Send for booklet giving full information and specifications.

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BIRMINGHAM	Brown-Marx Bldg.	SALT LAKE CITY	Walker Bank Bldg.
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BOSTON	Statler Bldg.	*LOS ANGELES	2087 E. Slauson Ave.
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*United States Steel Products Company

Uniform Quality Assured

WELDERS who use Commercial Acetylene soon learn that every cylinder contains the same pure gas.

Your torch can tell the difference!

COMMERCIAL ACETYLENE
Means pure acetylene.

COMMERCIAL SERVICE
Means prompt service.

No matter what your gas requirements may be you will be interested in our sales plan. Ask our nearest office to tell you about it.

Supplied in the following size cylinders:

10x30-in. size	125 cu. ft. cap.
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In the searching market of today Torchweld is the one gas welding and cutting equipment regarding which buyers have no doubts. Torchweld Quality and Value are certain.

Torchweld is definite assurance of longer life, more economy, finer performance and greater satisfaction with positive safety.

Leadership is theirs by right of performance, for Torchweld gives complete satisfaction.

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The Standard of Comparison

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TORCHWELD EQUIPMENT COMPANY
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After all—there is no better machine!

Cleaner welds mean better jobs and Better Jobs mean more jobs.

Biax guarantees its shaft to do your work for a year.

Write today for full information and catalogue E.

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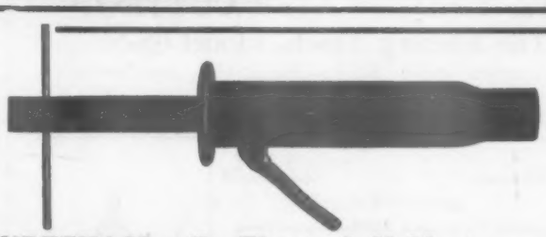

$4.50

UREEKA Metallic Electrode Holder

Permits the holding of electrode with tremendous pressure, but requires only very slight pressure to release. Perfect electrical contact between electrode and holder, with elimination of current losses and overheating. For 1/8" to 1/4" diameter electrodes.

GREAT STRENGTH. LIGHT WEIGHT. AMPLE CURRENT CAPACITY. NO SPRINGS.
Saves time, current, rod and worry. Try it.

$10

VULCAN Carbon Electrode Holder

for all heavy duty carbon arc welding

Positively will not overheat. Light weight. Easy to manipulate. 200, 400 and 600 ampere sizes for 1/2", 3/4" and 1" diameter Electrode.

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The Fibre-Metal Products Co.

Designers and Manufacturers since 1914 of Bower's Welding Helmets and Hand Shields
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"..we obtain the best results from the ARMCO Welding Wire"

SACO-LOWELL SHOPS
Textile Machinery
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P. F. McDonald & Co.,
Boston 27, Mass.

Lowell, Mass., April 12

Gentlemen: Attention: Mr. Morrissey

We have two installations of _____ Welding equipment consisting of six units. The first was installed in 1920 and proved so satisfactory that a second installation was put in three years later.

Since we machine the welding joint on all our work, it is essential that we use proper welding wire. At the beginning we experimented with various makes and soon found that we obtained the best results from the use of Armco Welding Wire. We have standardized on this wire for all of our welding work.

Very truly yours,
SACO-LOWELL SHOPS
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IT will pay anyone to investigate Page electrodes if they wish to "obtain the best results." Your name and address will bring the "Page Welding Wire Hand Book" and a sample of Page electrodes.

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SHOOT-A-LITE

SAFE!
SURE!!
STRONG!!!

The finest torch lighting device ever made. Try it.

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For UNDERWATER CUTTING
The Ellsberg Torch, Model "S-51"
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Using Oxygen, Hydrogen and Compressed Air

Any Thickness — Any Depth
ANYWHERE
Complete Units and Skilled Operators
By the Day or on contract
Prompt Service—Reasonable Rates

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Standard Seamless Steel Cylinders

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Arc Welding Handbook

BY C. J. HOLSLAG

A simple and practical manual of instruction in arc welding. The beginner is led step by step to complete mastery of the process. The supervisor is furnished a reliable guide for the training of new operators. The experienced operator is posted on principles which were overlooked in his first teaching.

250 Pages

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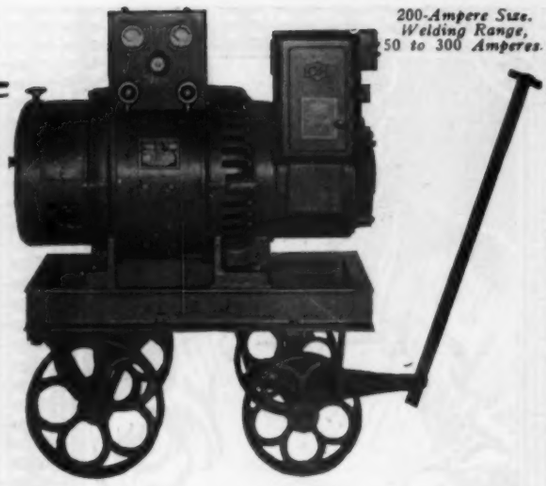

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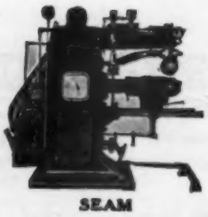

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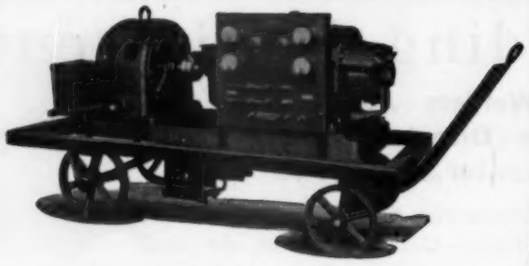

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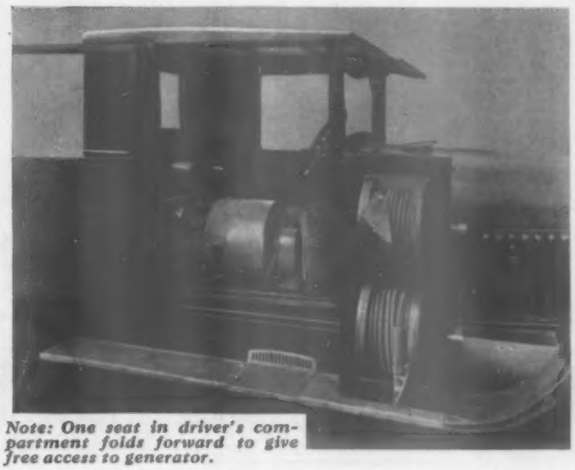

Note: One seat in driver's compartment folds forward to give free access to generator.

SPECIFICATIONS

GENERATOR: 300 amperes continuous; 400 amperes intermittent; ball bearing, 950 R.P.M.; extra heavy duty type.

POWER TAKE-OFF: Specially designed for welding service. Connected directly in drive line, provided with shifting lever for driving either car or generator.

GOVERNOR: Patented electric control. Does not affect car speed when generator is idle. Prevents surging of motor. Provides perfect inherent ampere control. Provides extremely elastic arc for all possible welding conditions.

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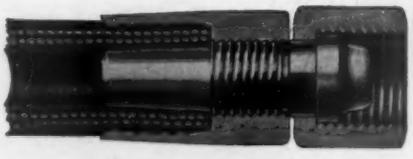

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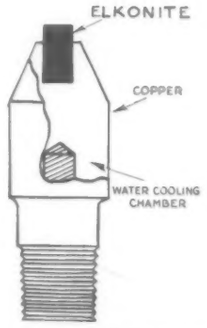

Fig. 1. Water cooled spot welding electrode showing Elkonite Insert. (Courtesy General Electric Co.)

The variable electrical and heat resistance of the different grades of Elkonite Welding Electrodes, plus their ability to hold their shape without mushrooming under red heat, heavy pressures and high currents are properties of immense value.

For this variable, relatively high resistance Elkonite as one electrode, with low resistance Elkonite or copper as the other, gives the balance necessary for even heating to welding temperature of metals of unequal heat and electrical conductivity, such as, for instance, copper with galvanized iron, or with nichrome.

METALS	ALUMINUM	ASCOLOY	BRASS	COPPER	GALVANIZED IRON	IRON	LEAD	MONEL	NICKEL	NICHROME	TIN PLATE	ZINC
ALUMINUM	•											
ASCOLOY		•		•	•	•		•	•	•	•	
BRASS			•	•	•	•		•	•	•	•	
COPPER		•	•	•	•	•		•	•	•	•	
GALVANIZED IRON		•	•	•	•	•		•	•	•	•	
IRON		•	•	•	•	•		•	•	•	•	
LEAD							•					
MONEL		•	•	•	•	•		•	•	•	•	
NICKEL		•	•	•	•	•		•	•	•	•	
NICHROME		•	•	•	•	•		•	•	•	•	
TIN PLATE		•	•	•	•	•		•	•	•	•	
ZINC												•

Fig. 2. Combinations of metals successfully welded with Elkonite. (Courtesy General Electric Co.)

This is but one phase of the contribution that Elkonite has made to resistance welding. In flash, cross-wire, projection welding, electrical upsetting of rivets, as well as in spot welding non-ferrous and heavy gauge ferrous metals Elkonite, by eliminating lost time and production due to constant redressing, and shrinkage loss, is showing new economies and production possibilities in many industries.

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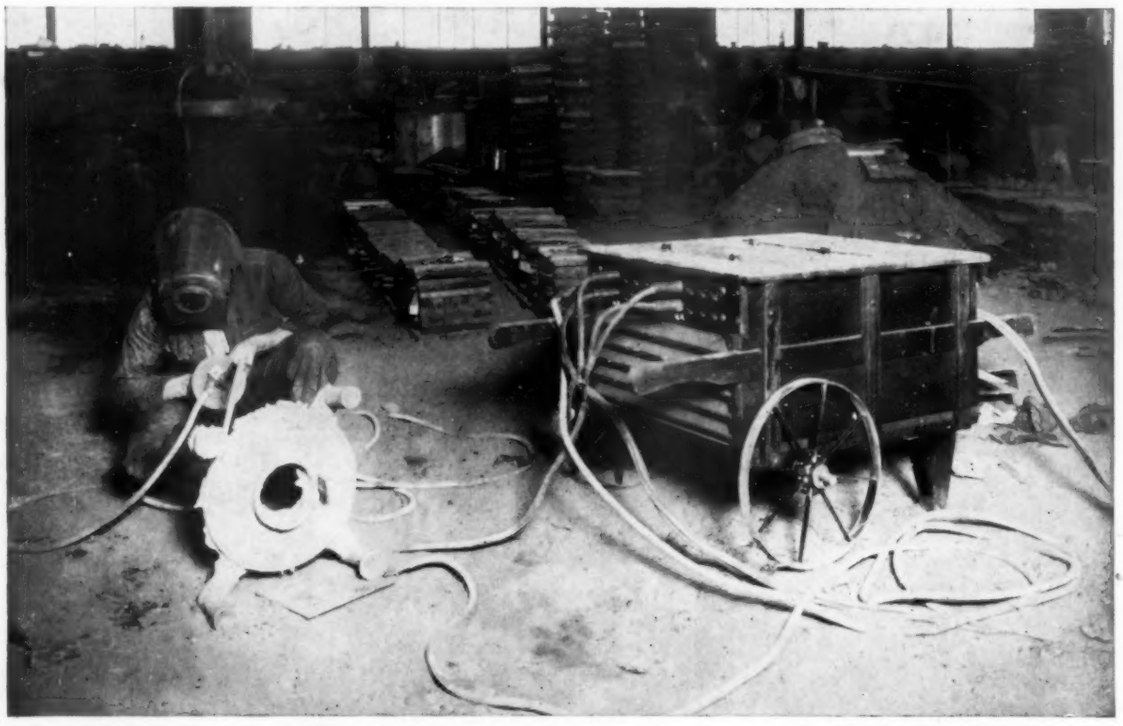
Exclusive licensees under General Electric Co. patents dated May 28, 1925 and Sept. 1, 1925. Other patents pending to Elkon Works.

ALTERNARC WELDERS



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